MITSUBISHI

Mitsubishi Industrial Robot

CR750-D/Q Series
CRnD/Q-700 Series
CRn-500 Series

MELFA-Works Instruction Manual

(3F-21D-WINE)

MELFA

BFP-A8525-G

Revision History

Date of print	Specifications No.	Revision details
2006-11-15	BFP-A8525-*	First release.
2007-02-08	BFP-A8525-A	Add the following chapters. 17.3 Open MXT file 17.5 How to teach the positional calibration program 17.6 How to teach the distortion calibration program 17.9 Movement Setting Change 17.11 Change error tolerance when calibration
2007-03-20	BFP-A8525-B	(For Version2.1) Edited target OS details. Add the Table 1-1 Relation CAD link function and Robot Version.
2008-03-03	BFP-A8525-C	(For Version2.2) ・ Corrected entry errors ・ Update operating system ・ Made compatible with SQ/SDseries ・ Added simultaneous install with RT ToolBox2 Added items for "Chapter 2.5 Startup-Quit Procedures(MELFA-Works)"
2008-11-07	BFP-A8525-D	(For Version3.0) Edited [1.Overview] Edited [2.Preparation before Starting] Edited [5.Starting and Closing] Add [5.5 Import] Edited [6.Robot setting] Edited [7.Layout] Add [7.2 Backup parts position] Add [7.3 Put back parts position] Edited [8.Robot operation] Edited [9.Calibration] Edited [10.Creation of Work Flow] Add [10.4.1.MXT with Travel base] Edited [11.Virtual Controller] Edited [12. Interference Check] Edited [17. How to Use the Calibration Tool]
2010-05-27	BFP-A8525-E	(For Version3.2) RV-2SD/SQ is added.
2010-10-22	BFP-A8525-F	(For Version3.3) The following models were added. RH-3SHxR3515 RH-6SxH3532/4532/5532 RH-12SxH5545/7045/8545 RH-20SxH8035/8045/10035/10045
2012-07-03	BFP-A8525-G	(For Version4.0) The following models were added. RH-3/6/12/20FH, RV-2/4/7F series The preservation number of part positions is changed. The installer is changed to 32bit/64bit. Edge/face is added to the click position movement. The output of a relative position is added to the work flow function. The resolution of Approach/Overrun distance is changed.

INTRODUCTION

Thank you for purchasing the MELFA-Works software package for Mitsubishi Electric industrial robots.
MELFA-Works is an add-in tool for SolidWorks that can be used to simulate Mitsubishi Electric industrial robots. Using MELFA-Works, it becomes possibloe to verify robot program operations and creat processing path data. This manual describes how to perform these operations.

This product requires SolidWorks. Please note that SolidWorks needs to be provided by the customer. Refer to “2.1 Operating Environment” for supported versions.

Symbols Used in This Manual

⚠ **DANGER**	Indicates that incorrect handling is likely to cause hazardous conditions resulting in death or severe injury to the operator.
⚠ **WARNING**	Indicates the possibility that incorrect handling might cause hazardous conditions resulting in death or severe injury to the operator.
⚠ **CAUTION**	Indicates that incorrect handling might cause hazardous conditions resulting in material damage or injury to the operator.

Table of Contents

1. Overview

MELFA-Works is an add-in tool that runs under SolidWorks, used for simulating production systems using robots on personal computers, converting processing paths defined for workpieces to data and outputting this data. And RT ToolBox2 (mini) for creating programs and changing parameters.

Since MELFA-Works is an add-in tool for SolidWorks, it is possible to make use of peripheral devices and parts such as hands created using SolidWorks as it is.

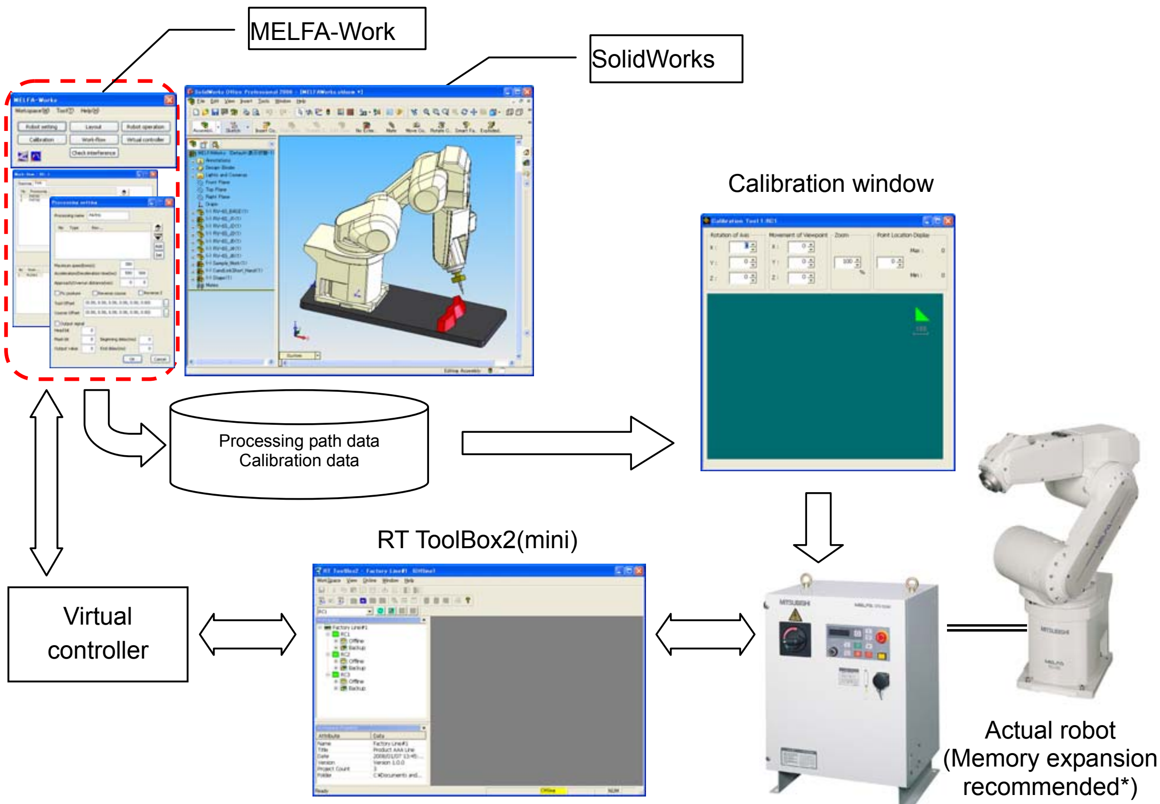


Fig. 1-1 Product Configuration

Extension memory can be used by the following controllers and versions.

Controller	Supported	Remarks
CRn-500	△ （2 Mbytes）	Before K6 Non-supported CAD link function K7 Non-supported extension memory Since K8 Supported extension memory
CRnD-700	○ （4 Mbytes）	P6 Non-supported extension memory Since P7 Supported extension memory
CRnQ-700	×	

The figure below illustrates a block diagram showing the components included in MELFA-Works and the environment in which each of them operates.

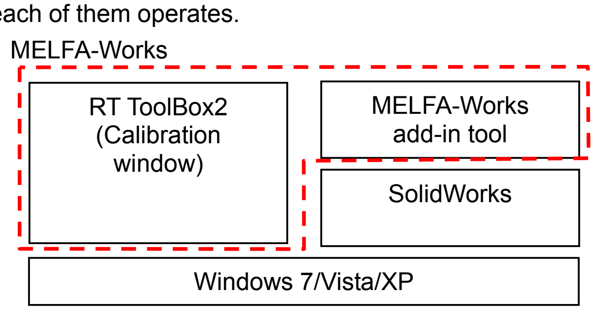


Fig. 1-2 Product Block Diagram

1.1. Basic Functions and Features

The table below describes the basic functions and features of MELFA-Works.

	Function	Feature
1	Robot model setting	This function allows selecting a model name from a displayed list and setting the robot model. A robot can be placed using positions relative to the CAD origin or other parts. Layout setting via value entry is also possible. * See "**Table 1-1 Robots that can be Used(CRn-500 series)**" for robots supported by this software.
2	Attaching hands	This function allows attaching hands designed and created using SolidWorks to a robot. It is also possible to specify ATC (Auto Tool Changer).
3	Travel axis	This function allows attaching a travel axis to a robot to verify system operations with a travel axis.
4	Loading and changing layout of peripheral devices	This function allows loading peripheral devices configured with SolidWorks parts. Loaded parts can be placed using positions relative to the CAD origin as well as other parts. Layout change via value entry is also possible.
5	Workpiece handling	It is possible to handle workpieces by simulating hand signals with robot programs. Note that it is necessary to set workpiece names according to the naming convention in order to handle the signals.
6	CAD link	This function allows creating data necessary for operations that would otherwise require large amounts of teaching, such as laser welding, sealing and other operations involving tracing some parts on a workpiece, simply by selecting processing parts from 3-dimensional CAD data. Since data is created based on 3-dimensional CAD data, it is possible to handle complicated, 3-dimensional curves and the man-hours required for the teaching can also be reduced significantly. * Only vertical 6-axis and horizontal 4-axis robots support this function. See "**Table 1-1 Robots that can be Used(CRn-500 series)**" for the details. * Using the expanded memory might extend the operating time. See "**Table 1-6 Relation CAD link function and Robot Version**" for more information. * This function supports the MELFA-BASIC IV and MELFA-BASIC V language.
7	Specification of robot program	With this function, it is possible to use programs used with actual robots as is. Also, in the same way as with an actual controller, it is possible to specify a robot program for each task slot.

	Function		Feature
8	Robot movement simulation		This function allows simulating a specified robot program. Since it also simulates input/output signals of a robot controller, it is possible to reproduce the same program movement as the actual system. The following two types of simulation methods of robot controller input/output signals are provided. (1) Method for defining input/output signal operations in a simple manner (2) Method for linking with GX Simulator * GX Simulator is support software for simulating Mitsubishi PLCs on a personal computer. It is used to debug sequence programs created by MELFA-Works.
9	Interference check		This function allows checking interference between a robot and peripheral devices. Targets of an interference check can be specified simply by clicking on the display. Also, information acquired when interference occurred (name of contacting part, program line being executed at the occurrence of interference, robot position, etc.) can be saved in log files.
10	Robot program debug function		The following functions are provided to debug robot programs.
		Step operation	Executes a specified program step by step.
		Break point	Allows stopping program execution at any specified line in the specified program.
		Direct execution	Executes an arbitrary robot command.
11	Jog operation		This function allows jog operation of a robot displayed in SolidWorks, just like executing actual robot jog operations on a teaching box.
12	Calibration		This function calibrates dot sequence data in the CAD coordinates created by the CAD link function so that they match data in robot coordinates. It is also possible to transfer movement programs and dot sequence data to a robot. The calibration tool can also be used on laptop computers on which SolidWorks is not installed. The calibration tool is included in RT ToolBox2, and can use it by installing MELFA-Works. * Only dot sequence data can be calibrated. See “10.2 Path Creation” for more information. Cannot calibrate teaching points (See 10.1 Creating Teaching Points).
13	Cycle time measurement		This function allows measuring the cycle time of robot movement from any point of time, just like using a stopwatch. It is also possible to measure cycle time at a specified program location.
14	Display of robot movement trajectory		With this function, it is possible to display the movement trajectory of a robot.
15	Saving moving images		With this function, it is possible to save moving images of simulated movement in a file (AVI format).

1.2. Supported Models

The table below lists models supported in MELFA-Works.

Table 1-1 Robots that can be Used(CRn-500 series)

Robot	Function	Simulation	CAD link
RV-S series	RV-3S/3SC/3SB/3SBC	○	○
	RV-3SJ/3SJC/3SJB/3SJBC	○	×
	RV-6S/6SC	○	○
	RV-6SL/6SLC	○	○
	RV-12S/12SC	○	○
	RV-12SL/12SLC	○	○
	RV-18S/18SC	○	○
	RV-6S/6SC-SM	○	○
	RV-6SL/6SLC-SM	○	○
	RV-6S-SE	○	○
	RV-6SL-SE	○	○
	RV-12S/12SC-SE	○	○
	RV-12SL/12SLC-SE	○	○
RH-SH series	RH-6SH3520/3717M/3717C	○	○
	RH-6SH4520/4517M/4517C	○	○
	RH-6SH5520/5517M/5517C	○	○
	RH-6SH3532/3520M/3520C	○	○
	RH-6SH4532/4520M/4520C	○	○
	RH-6SH5532/5520M/5520C	○	○
	RH-12SH5535/5530M/5530C	○	○
	RH-12SH7035/7030M/7030C	○	○
	RH-12SH8535/8530M/8530C	○	○
	RH-18SH8535/8530M/8530C	○	○
RV-A series	RV-1A	○	○
RP series	RP-1AH	○	○
	RP-3AH	○	○
	RP-5AH	○	○

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-2 Robots that can be Used(CRnD-700 series)

Robot	Function	Simulation	CAD link
RV-SD series	RV-2SD/2SDB	○	○
	RV-3SD/3SDB/3SDC/3SDBC	○	○
	RV-3SDJ/3SDJB/3SDJC/3SDJBC/3SDJ-SR	○	×
	RV-6SD/6SDC	○	○
	RV-6SDL/6SDLC	○	○
	RV-12SD/12SDC	○	○
	RV-12SDL/12SDLC	○	○
	RV-18SD/18SDC	○	○
	RV-3SDB/3SDBC-SUL3	○	○
	RV-3SDB/3SDJB-SULM6	○	○
	RV-3SDJB/3SDJBC-SUL3	○	×
	RV-6SD/6SDC-SUL	○	○
	RV-6SD-SULM6	○	○
	RV-6SDL/6SDLC-SUL	○	○
	RV-6SDL-SULM6	○	○
	RV-12SD/12SDC-SUL	○	○
	RV-12SDL/12SDL-SUL	○	○

	RV-6SD-SE	○	○
	RV-6SDL-SE	○	○
	RV-6SD-SEZ	○	○
	RV-6SDL-SEZ	○	○
	RV-6SD/6SDC-SM	○	○
	RV-6SDL/6SDLC-SM	○	○
	RV-6SD/6SDC-SMZ	○	○
	RV-6SDL/6SDLC-SMZ	○	○
	RV-6SD/6SDC-SZ	○	○
	RV-6SDL/6SDLC-SZ	○	○
	RV-12SD/12SDC-SE	○	○
	RV-12SDL/12SDLC-SE	○	○
	RV-12SD/12SDC-SEZ	○	○
	RV-12SDL/12SDLC-SEZ	○	○
	RV-12SD/12SDC-SZ	○	○
	RV-12SDL/12SDLC-SZ	○	○
RH-SDHR series	RH-3SDHR3515	○	○
RH-SDH series	RH-6SDH3520/3520M/3520C/3517M/3517C	○	○
	RH-6SDH4520/4520M/4520C/4517M/4517C	○	○
	RH-6SDH5520/5520M/5520C/5517M/5517C	○	○
	RH-6SDH3532/3527M/3527C	○	○
	RH-6SDH4532/3527M/4527C	○	○
	RH-6SDH5532/3527M/5527C	○	○
	RH-12SDH5535/5530M/5530C	○	○
	RH-12SDH7035/7030M/7030C	○	○
	RH-12SDH8535/8530M/8530C	○	○
	RH-12SDH5545/5538M/5538C	○	○
	RH-12SDH7045/7038M/7038C	○	○
	RH-12SDH8545/8538M/8538C	○	○
	RH-18SDH8535/8530M/8530C	○	○
	RH-6SDH3520/3517M/3517C-SUL3	○	○
	RH-6SDH4520/4517M/4517C-SUL3	○	○
	RH-6SDH5520/5517M/5517C-SUL3	○	○
	RH-6SDH3517M-SULM6	○	○
	RH-6SDH4517M-SULM6	○	○
	RH-6SDH5517M-SULM6	○	○
	RH-12SDH5535/5530M/5530C-SUL	○	○
	RH-12SDH7035/7030M/7030C-SUL	○	○
	RH-12SDH8535/8530M/8530C-SUL	○	○
	RH-12SDH5530M-SULM6	○	○
	RH-12SDH7030M-SULM6	○	○
	RH-12SDH8530M-SULM6	○	○
	RH-18SDH8535-SUL	○	○
	RH-18SDH8530M-SUL	○	○
	RH-18SDH8530C-SUL	○	○
	RH-18SDH8530M-SULM6	○	○
	RH-20SDH8535/8530M/8530C	○	○
	RH-20SDH8545/8538M/8538C/8545M/8545C	○	○
	RH-20SDH10035/10030M/10030C	○	○
	RH-20SDH10045/10038M/10038C	○	○

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-3 Robots that can be Used(CRnQ-700 series)

Robot \ Function		Simulation	CAD link
RV-SQ series	RV-2SQ/2SQB	○	○
	RV-3SQ/3SQB/3SQC/3SQBC	○	○
	RV-3SQJ/3SQJB/3SQJC/3SQJBC/3SQJ-SR	○	×
	RV-6SQ/6SQC	○	○
	RV-6SQL/6SQLC	○	○
	RV-12SQ/12SQC	○	○
	RV-12SQL/12SQLC	○	○
	RV-18SQ/18SQC	○	○
	RV-6SQ-SE	○	○
	RV-6SQL-SE	○	○
	RV-6SQ-SEZ	○	○
	RV-6SQL-SEZ	○	○
	RV-6SQ/6SQC-SM	○	○
	RV-6SQL/6SQLC-SM	○	○
	RV-6SQ/6SQC-SMZ	○	○
	RV-6SQL/6SQLC-SMZ	○	○
	RV-6SQ/6SQC-SZ	○	○
	RV-6SQL/6SQLC-SZ	○	○
	RV-12SQ/12SQC-SE	○	○
	RV-12SQL/12SQLC-SE	○	○
	RV-12SQ/12SQC-SEZ	○	○
	RV-12SQL/12SQLC-SEZ	○	○
	RV-12SQ/12SQC-SZ	○	○
	RV-12SQL/12SQLC-SZ	○	○
RH-SQHR series	RH-3SQHR3515	○	○
RH-SQH series	RH-6SQH3520/3517M/3517C/3520M/3520C	○	○
	RH-6SQH4520/4517M/4517C/4520M/4520C	○	○
	RH-6SQH5520/5517M/5517C/5520M/5520C	○	○
	RH-6SQH3532/3527M/3527C	○	○
	RH-6SQH4532/4527M/4527C	○	○
	RH-6SQH5532/5527M/5527C	○	○
	RH-12SQH5535/5530M/5530C	○	○
	RH-12SQH7035/7030M/7030C	○	○
	RH-12SQH8535/8530M/8530C	○	○
	RH-12SQH5545/5538M/5538C	○	○
	RH-12SQH7045/7038M/7038C	○	○
	RH-12SQH8545/8538M/8538C	○	○
	RH-18SQH8535/8530M/8530C	○	○
	RH-20SQH8535/8530M/8530C	○	○
	RH-20SQH8545/8538M/8538C	○	○
	RH-20SQH10035/10030M/10030C	○	○
	RH-20SQH10045/10038M/10038C	○	○

*CAD link function only supports vertical 6-axis and horizontal 4-axis robots.

Table 1-4 Robots that can be Used(CRn750-D series)

Robot \ Function		Simulation	CAD link
RH-FH-D series	RH-3FH3515/3512C-D	○	○
	RH-3FH4515/4512C-D	○	○
	RH-3FH5515/5512C-D	○	○

	RH-6FH3520/3520C/3520M-D	○	○
	RH-6FH4520/4520C/4520M-D	○	○
	RH-6FH5520/5520C/5520M-D	○	○
	RH-6FH3534/3534C/3534M-D	○	○
	RH-6FH4534/4534C/4534M-D	○	○
	RH-6FH5534/5534C/5534M-D	○	○
	RH-12FH5535/5535C/5535M-D	○	○
	RH-12FH7035/7035C/7035M-D	○	○
	RH-12FH8535/8535C/8535M-D	○	○
	RH-12FH5545/5545C/5545M-D	○	○
	RH-12FH7045/7045C/7045M-D	○	○
	RH-12FH8545/8545C/8545M-D	○	○
	RH-20FH8535/8535C/8535M-D	○	○
	RH-20FH8545/8545C/8545M-D	○	○
	RH-20FH10035/10035C/10035M-D	○	○
	RH-20FH10045/10045C/10045M-D	○	○
RV-F-D series	RV-2F-D	○	○
	RV-4F-D / RV-4F-D-SH	○	○
	RV-4FL-D / RV-4FL-D-SH	○	○
	RV-7F-D / RV-7F-D-SH	○	○
	RV-7FL-D / RV-7FL-D-SH	○	○

Table 1-5 Robots that can be Used(CRn750-Q series)

Robot	Function	Simulation	CAD link
RH-FH-Q series	RH-3FH3515/3512C-Q	○	○
	RH-3FH4515/4512C-Q	○	○
	RH-3FH5515/5512C-Q	○	○
	RH-6FH3520/3520C/3520M-Q	○	○
	RH-6FH4520/4520C/4520M-Q	○	○
	RH-6FH5520/5520C/5520M-Q	○	○
	RH-6FH3534/3534C/3534M-Q	○	○
	RH-6FH4534/4534C/4534M-Q	○	○
	RH-6FH5534/5534C/5534M-Q	○	○
	RH-12FH5535/5535C/5535M-Q	○	○
	RH-12FH7035/7035C/7035M-Q	○	○
	RH-12FH8535/8535C/8535M-Q	○	○
	RH-12FH5545/5545C/5545M-Q	○	○
	RH-12FH7045/7045C/7045M-Q	○	○
	RH-12FH8545/8545C/8545M-Q	○	○
	RH-20FH8535/8535C/8535M-Q	○	○
	RH-20FH8545/8545C/8545M-Q	○	○
	RH-20FH10035/10035C/10035M-Q	○	○
	RH-20FH10045/10045C/10045M-Q	○	○
RV-F-Q series	RV-2F-Q	○	○
	RV-4F-Q / RV-4F-Q-SH	○	○
	RV-4FL-Q / RV-4FL-Q-SH	○	○
	RV-7F-Q / RV-7F-Q-SH	○	○
	RV-7FL-Q / RV-7FL-Q-SH	○	○

Table 1-6 Relation CAD link function and Robot Version

<table>
<tr><th>Controller</th><th>Memory</th><th>Operating time</th><th>Remarks</th></tr>
<tr><td rowspan="2">CRn-500</td><td>Standard 256K bytes</td><td>Approx. 17 sec</td><td rowspan="2">Before K6 Non-supported CAD link function
K7 Non-supported extension memory
Since K8 Supported extension memory</td></tr>
<tr><td>Extension 2M bytes</td><td>Approx. 160 sec</td></tr>
<tr><td rowspan="2">CRnQ-700
CRn750-Q</td><td>Standard 1M bytes</td><td>Approx. 85 sec</td><td rowspan="2">Correspondence from first edition.</td></tr>
<tr><td>-</td><td>Non-supported</td></tr>
<tr><td rowspan="2">CRnD-700</td><td>Standard 1M bytes</td><td>Approx. 85 sec</td><td rowspan="2">P6 Non-supported extension memory
Since P7 Supported extension memory</td></tr>
<tr><td>Extension 4M bytes</td><td>Approx. 320 sec</td></tr>
<tr><td>CRn750-D</td><td>Standard 3M bytes</td><td>Approx. 255 sec</td><td>Correspondence from first edition.</td></tr>
</table>

* Operating time varies depending on the job conditions.

2. Preparation before Starting

2.1. Operating Environment

The table below shows the specifications of the operating environment of MELFA-Works and the personal computer on which the RT ToolBox2(mini) runs.

Table 2-1 MELFA-Works Operating Environment

Item	Minimum Requirement	Recommended
CPU	Refer to the recommended SolidWorks environment. *1	
Main memory	Refer to the recommended SolidWorks environment. *1	
Graphic display	XGA (1024x768) or more	SXGA (1280x1024) or more Video card installed *1
Hard disk	1 GB or more free space	
Disk device	CD-ROM drive	
Pointing device	Must operate in Microsoft Windows® environment With wheel button	
Keyboard	PC/AT compatible keyboard	
OS	Microsoft Windows® XP Professional (32bit) SP3 Microsoft Windows® Vista Professional (32bit) Microsoft Windows® 7 Professional (32bit/64bit) * A language intends for only a **English edition**. Cannot guarantee of product, if it was used by other languages. * 64bit OS is non-correspondence.	
3D-CAD	SolidWorks®2010 ～ SolidWorks®2012 * The above-mentioned is a confirmed operation version in our company. Therefore, it is likely to be able to use it even with SolidWorks that will be released in the future. * MELFA-Works will not operate normally on SolidWorks 2006 SP0.0, so please upgrade to the latest SP version of SolidWorks. * Due to the specifications of SolidWorks, it is not possible to migrate data created by a later version to an earlier version.	
RT ToolBox2	It is bundled to setup CD of MELFA-Works. If RT ToolBox2 is not installed, the simulator function cannot be used, so please install it. If you use RT ToolBox2 not bundled to MELFA-Works, Please use RT ToolBox2 since Ver.2.00A.	
External application	GX Simulator Version 7 * Used to simulate input/output signals using ladder programs.	

*1 For the recommended SolidWorks operating environment,
http://www.solidworks.com/ Please refer to Home page of SolidWorks (SolidWorks Corp.)
[Top page]-[TRAINING & SUPPORT]-[Technical Support]-[System Requirements and Graphics Cards]

2.2. Confirmation of the Product

(1) Confirmation of Package

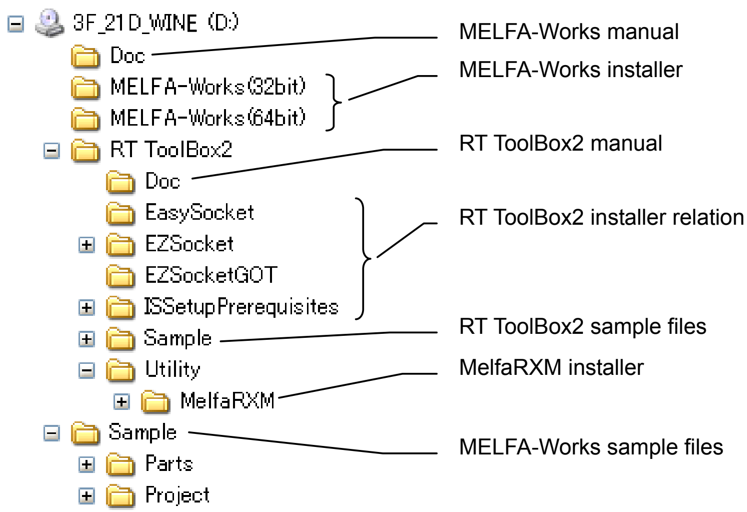
Check that the following items are included in the package.

- ☐ CD-ROM “MELFA-Works”
- ☐ Setup Guide
- ☐ Software License Agreement
- ☐ License Certification (Please make sure that the product name and product ID are printed on it.)

* If any item is missing, please contact the dealer from which you purchased the product.

(2) Confirmation of CD-ROM

The data on the CD-ROM has the following structure.



2.3. Installation (MELFA-Works)

This section explains how to install the software.

2.4. Flow of installation

Start

① Insert the CD-ROM in the personal computer's CD-ROM drive.

② Run "index.html" in the CD-ROM (perform this step if the file is not executed automatically in step ①).

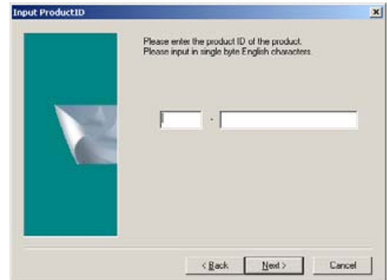
③ Selection of installed application
(Please install RT ToolBox2 previously)

④ Start installation.

⑤ Check License Agreement.

⑥ Enter user information (user name, company name).

⑦ Enter the product ID*1 of the purchased product.



⑧ Select an installation destination.

⑨ Finish installation.

⑩ Start the product to check that it is properly installed.

Finish

*1 The product ID is printed on the License Certification. Please use Product ID of RT ToolBox2 the same one as MELFA-Works.

⚠ CAUTION

Please install MELFA-Works in the same folder as RT ToolBox2.

MELFA-Works uses the function of RT ToolBox2, and please install it in the same folder.
It doesn't operate correctly when installing it in another folder.
When RT ToolBox2 is installed beforehand, MELFA-Works is installed in the same place as RT ToolBox2.

2.5. Installation Procedure

(1) Insert the product in the personal computer's CD-ROM drive; the setup launcher automatically appears.

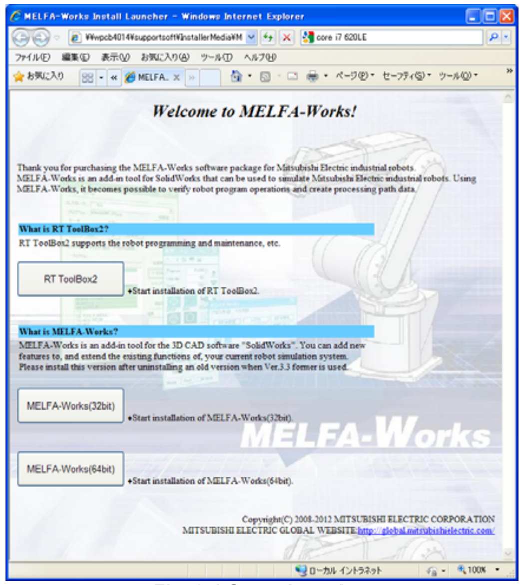


Fig. 2-1 Setup launcher

MELFA-Works corresponds to 32bit and 64bit OS more than Ver.4.0. Please start a correct installer after confirming the use environment when you install it. The error is displayed when a wrong installer is started and the installation fails.
32bit/64bit is common to the installer of RT ToolBox2.

*The following messages concerning security alert might be displayed to launcher according to the environment of the personal computer. In this case, click the message with the mouse, and select [Allow Blocked Content…].

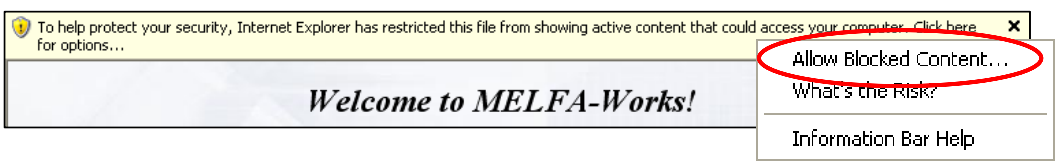


Fig. 2-2 Message to help protect your security (Microsoft Windows® XP Professional is used)

(2) Install RT ToolBox2 and MELFA-Works from the menu of launcher. MELFA-Works is must be installed to the same folder as RT ToolBox2. If RT ToolBox2 is installed first, the same folder is set as default MELFA-Works installation folder.

① Click the button of the installed product.
② If the security alert message as follows is displayed, click [Run] button.
(* If [Save] button is clicked and, "Setup.exe" which is saved in hard disk is executed, the installation is not correctly completed. Click [Run] button absolutely.)

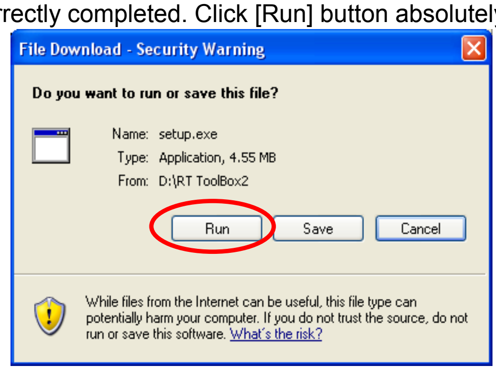


Fig. 2-3 Security Warning 1

③ The following screens are displayed. Then click [Run].
The installation of this application is started.

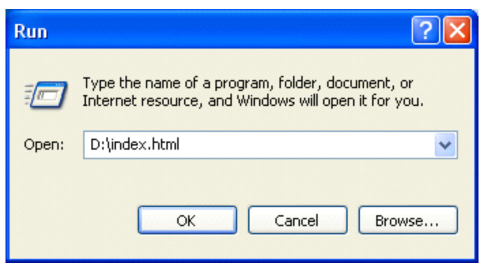
Fig. 2-4 Security Warning 2

Memo

When the installation launcher doesn't start

(A) If the setup dialog box does not appear when you insert the product in the CD-ROM drive, display the setup launcher according to the following procedure.

① Click the [Start] button and then select [Run...].
② Check the CD-ROM drive name and enter "drive name":/index.html
(e.g., if the CD-ROM drive is "D:," type “D:/index.html”).



(B) Please install RT ToolBox2 and MELFA-Works by the method of the following when the installation cannot begin from the setup launcher.

① Click the [Start] button and then select [Run...].
② Check the CD-ROM drive name and enter "drive name":/RT ToolBox2/Setup.exe
(e.g., if the CD-ROM drive is "D:," type “D:/RT ToolBox2/Setup.exe”).
The setup is begun.
③ As well as ② after completing the setup of RT ToolBox2
enter "drive name":/MELFA-Works/Setup.exe (e.g., if the CD-ROM drive is "D:," type “D:/MELFA-Works/Setup.exe”).
The setup is begun.

2.6. Startup-Quit Procedures(MELFA-Works)

＜Startup＞

Start up SolidWorks.
If SolidWorks is already running then close all windows.
Select MELFA-Works from the main menu and click “Start”.

＜Quit＞

Click the [X] box on the MELFA-Works main window.

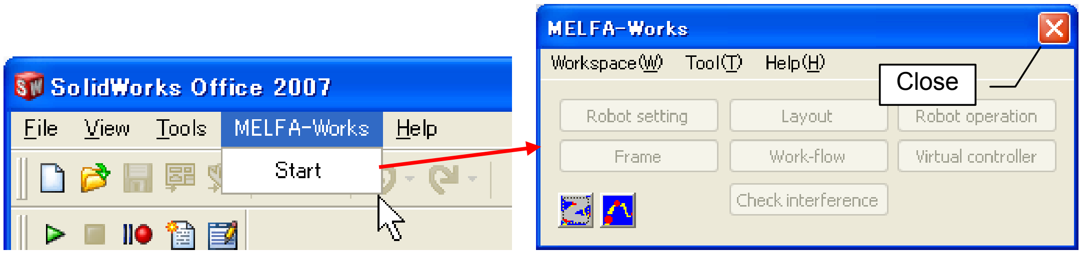


Fig. 2-5 Startup-Quit

CAUTION

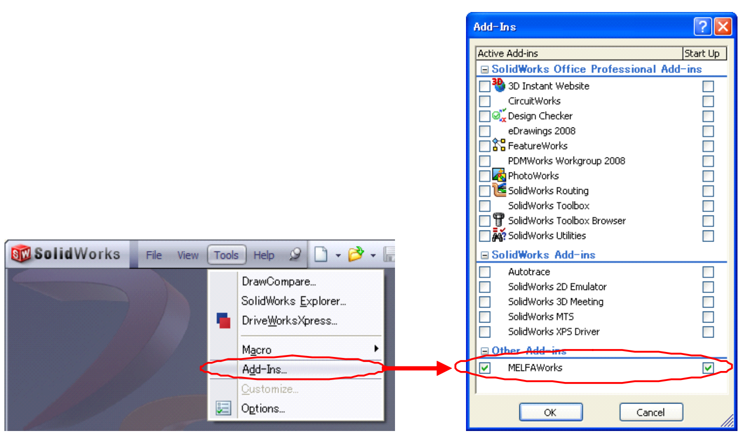
Close all SolidWorks sub-windows during startup.

The MELFA-Works menu will not appear if the SolidWorks sub-windows are open.

Memo

When "MELFA-Works" is not displayed in the menu

When "MELFA-Works" is not displayed in the menu of SolidWorks after it installs
It. "Add-in" is clicked from the tool menu of SolidWorks.
Please make "MELFA-Works" effective from a set screen of the [Add-Ins].



3. Flow of Operations

This chapter explains the flow of operations involved in starting up a system using MELFA-Works, up to operating a robot in its actual environment. The specific operations that can be carried out in each dialog box/window are explained in the subsequent chapters; refer to the corresponding chapter for further details.

3.1. Operation Steps

Several operations are involved in constructing a system using MELFA-Works. They can largely be divided into the following 4 steps.

Table 3-1 Operation Steps

① Using "SolidWorks"	Create workpieces, hands and other parts in SolidWorks and convert other CAD data to mark for MELFA-Works. In MELFA-Works the coordinate system are used as marks for SolidWorks functions. (Chapter 4.2 Part Names and Marking)
② Using "MELFA-Works"	Use MELFA-Works to specify processing locations, intermediate postures and various parameters to eventually create template robot programs, dot sequence data and calibration programs.
③ Using "calibration tool"	Use the calibration tool to calibrate dot sequence data to processing positions of workpieces in the actual space. Download the calibrated dot sequence data to a robot controller.
④ Using "RT ToolBox2"	Use RT ToolBox2 to create programs that are operable in actual systems based on the template programs created in step ②. Debug the created operational programs.

3.2. Flow of Robot Program Development

This section explains how to develop robot programs without using the CAD link function. Refer to the corresponding chapter for further details. The numbers ① to ④ to the left of each of the items indicate the operation steps explained in “Chapter3.1 Operation Steps”.
To use CAD link functions see 3.3 “OverviewFlow of CAD Link System Development”.

①	Create parts required for simulation	Create workpieces, hands and other parts in SolidWorks. “Chapter4 Creation of Parts”
②	↓ Create a project	Create a new project or load an existing project. “Chapter 5 Starting and Closing”
	↓ Load a robot	Load a robot by selecting from a list. “Chapter 6 Robot Setting”
	↓ Attach hands	Attach hands (fixed hands, ATC) to the robot. It is also possible to make signal settings for simulation. ”Chapter 6 Robot Setting”
	↓ Mount on travel base	Mount the robot on a travel base. Moving direction and target axes are set here as well. ”Chapter6 Robot Setting”
	↓ Place peripheral devices	Place loaded peripheral devices in arbitrary positions. ”Chapter 7 Layout”
	↓ Place robot	Place the loaded robot to an arbitrary location. ”Chapter 7 Layout”
	↓ Change posture	Change the robot posture. ”Chapter 8 Robot Operations”
	↓ Teach posture	Teach the robot postures of operations. ”Chapter 10 Creation of Work Flow”
	↓ Create work flow	Specify the work flow by combining teaching points and paths. “Chapter 10 Creation of Work Flow”
	↓ Create a program	Create a robot movement program based on a work flow. “Chapter 10 Creation of Work Flow”
	↓ Check movement with a virtual controller	Using a virtual controller allows checking the movement in advance. ”Chapter 11 Virtual Controller”
④	↓ Create an operational program	Modify an automatically created program according to your specific system using RT ToolBox2. ”Chapter 18 CAD Link Programming”

3.3. Flow of CAD Link System Development

This section explains the flow of development of robot programs using the CAD link function. The numbers ① to ④ to the left of each of the items indicate the operation steps explained in “3.1 Operation Steps”.

①	Create parts required for simulation	Create workpieces, hands and other parts in SolidWorks. “Chapter4 Creation of Parts”
②	Create a project	Create a new project or load an existing project. “Chapter 5 Starting and Closing”
②	Load a robot	Load a robot by selecting from a list. “Chapter 6 Robot Setting”
②	Attach hands	Attach hands (fixed hands, ATC) to the robot. It is also possible to make signal settings for simulation. ”Chapter 6 Robot Setting”
②	Mount on travel base	Mount the robot on a travel base. Moving direction and target axes are set here as well. ”Chapter6 Robot Setting”
②	Place peripheral devices	Place loaded peripheral devices in arbitrary positions. ”Chapter 7 Layout”
②	Place robot	Place the loaded robot to an arbitrary location. ”Chapter 7 Layout”
②	Change posture	Change the robot posture. ” Chapter 8 Robot Operations”
②	Create calibration data	Specify reference points used in the operation. “Chapter 9 Frame”
②	Teach posture	Teach the robot postures of operations. ”Chapter 10 Creation of Work Flow”
②	Create work flow	Specify the work flow by combining teaching points and paths. ”Chapter 10 Creation of Work Flow”
②	Create a program	Create a robot movement program based on a work flow. ”Chapter 10 Creation of Work Flow”
②	Check movement with a virtual controller	Using a virtual controller allows checking the movement in advance. ”Chapter 11 Virtual Controller”
③	Teach calibration points	Transfer the calibration program to the controller in order to teach the robot. “Chapter 17 How to Use the Calibration Tool”
③	Calibrate dot sequence and transfer to controller	Perform calibration using the teaching result and transfer the calibrated dot sequence data to the controller. “Chapter 17 How to Use the Calibration Tool”
④	Create an operational program	Modify an automatically created program according to your specific system using RT ToolBox2. ”Chapter 18 CAD Link Programming”

4. Creation of Parts

With MELFA-Works, parts created by customers can be used as hands or workpieces. When attaching hands or similar on a robot and handling workpieces, such parts should be created in advance by following the creation rules explained in this chapter.
The operations mentioned above are not required to simply operate a robot.
Sample data for hands, workpieces, travel bases and so forth can be found in the sample folder; please make use of them as reference.

4.1. File Formats that can be Used

MELFA-Works is able to use data created by other CAD software as far as the data is stored using file formats that can be loaded by SolidWorks.
In that case, load the file after converting it to a SolidWorks part file (*.sldprt format).

SolidWorks currently supports the following file formats.

IGES	VRML	HOOPS
STEP	VDA－FS	PAR（Solid　EdgeTM）
SAT（ACISR）	Pro/ENGINEERR	IPT（Autodesk　Inventor）
ParasolidR	Unigraphics	Mechanical　Desktop
DWG	CADKEYR	CGR（CATIARgraphics）
DXFTM	Viewpoint	HCG　（Highly compressed graphic）
STL	RealityWave	

* Please check the latest specifications at the Website of SolidWorks Corporation.

4.2. Part Names and Marking

The main part types used in MELFA-Works include robot components, hands, travel bases, workpieces and other peripheral devices. Among these, some parts are handled in a special manner by MELFA-Works, and several rules thus apply.

The rules can mainly be categorized into the following two types.

① Part Names
Part names loaded in SolidWorks, which correspond to file names, are used to distinguish whether the part is a hand, workpiece or something else. Insert "**_identifier**" before the file extension as a character string that distinguishes among parts, as in the following example.
(Example) Sample**_identifier**.sldprt
※ See Table 4-1 for "identifier" (extension) information.

② Marking
In order to have a reference frame for connecting parts, such as a robot and a hand or a hand and a workpiece, a "coordinate system" with a specific name must be embedded in a part.
※ Coordinate system names are grouped in small or large letters.

③ File Format
Only the Partsfile (*.sldprt) can be recognized from among MELFA-Works components such as hand and work. The Assembly file (*.sldasm) cannot be used so please convert to a parts file before using.　After conversion for the interference check, specify Solid File and store.

Table 4-1 Rules in Parts Creation

<table>
<tr><th>Part name</th><th>Format of part name
(= file name)</th><th>First origin
(for connecting robot)</th><th>Second origin
(for connecting workpieces)</th></tr>
<tr><td>Fixed hand</td><td>Arbitrary character string +
“_Hand.sldprt"

(Example) Sample_Hand.sldprt</td><td rowspan="2">Coordinate system:
Orig1</td><td rowspan="2">In the case of gripping hands
Coordinate system: Pick1 to 8
* Set to gripping area

In the case of processing hands
Coordinate system: Orig2
* Set to processing point</td></tr>
<tr><td>ATC tool</td><td>Arbitrary character string +
“_ToolATC.sldprt"

(Example)
Sample_ToolATC.sldprt</td></tr>
<tr><td>ATC master</td><td>Arbitrary character string +
“_MasterATC.sldprt"

(Example)
Sample_MasterATC.sldprt</td><td>Coordinate system:
Orig1</td><td>Coordinate system: Orig2</td></tr>
<tr><td>Workpiece</td><td>Arbitrary character string +
“_Work.sldprt"

(Example) Sample_Work.sldprt</td><td>Coordinate system:
Orig1
* Set to gripping area
(Can be omitted)</td><td>None</td></tr>
<tr><td>Travel base</td><td>Arbitrary character string +
“.sldprt"

(Example) Sample.sldprt</td><td>Coordinate system:
Arbitrary
(Multiple coordinate systems can be used.)</td><td>None</td></tr>
</table>

Orig1 or 2: Used to connect of parts in front and back. The second origin of a part in front and the first origin of a part in back match, for example **Orig2** of J6 axis of a 6-axis robot and **Orig1** of a fixed hand, as well as **Orig1** of the ATC master and **Orig2** of the ATC tool.

Pick1 to 8: Used to determine the position of a gripped workpiece.

⚠ CAUTION

Do not store your product files in the project folder.

MELFA-Works operates the project folder. So unexpected files found when closing the project will cause a file copy error that might prevent the created project from being saved correctly. Make a special folder for your product and store your product file there.

4.3. Hand Design

MELFA-Works can handle the following hands.

Table 4-2 Hands that can be Used

Type	Explanation
Fixed hand	Fixed hands are directly attached to a flange.
ATC master	The master side of ATC (Auto Tool Changer). The ATC master part is directly attached to a flange. The ATC tool can be removed or attached according to commands issued via robot input/output signals. In order to attach the tool via a signal, the ATC tool must be in the vicinity of the robot (no more than 200 mm away).
ATC tool	The tool side of ATC. The ATC tool side is fixed to the ATC master.

Two types of hand applications, gripping hands and processing hands, can also be handled by this software. These types of hand applications are defined as follows.

Table 4-3 Hand Applications

Type	Explanation
Gripping hand	A gripping hand is used to handle workpieces. Up to 8 gripping areas can be set for each hand and it is possible to grip up to 8 workpieces at the same time. The workpiece must be in the vicinity of the gripping hand.(no move then 200mm away.) **A marking (Pick 1 to 8)** is required for each gripping area.
Processing hand	A processing hand is used in laser welding, sealing and other operations that involve tracing of specific locations on a workpiece. **A marking (Orig2)** is required for the hand processing point.

4.3.1 Example of Part Creation 1

In order to allow MELFA-Works to handle a part, the part name, first origin and second origin must be specified according to the rules shown in “Table 4-1 Rules in Parts Creation”.

First origin: For connecting with a part closer to the robot origin (part in front)
Second origin: For connecting with a part farther from the robot origin (part in back)

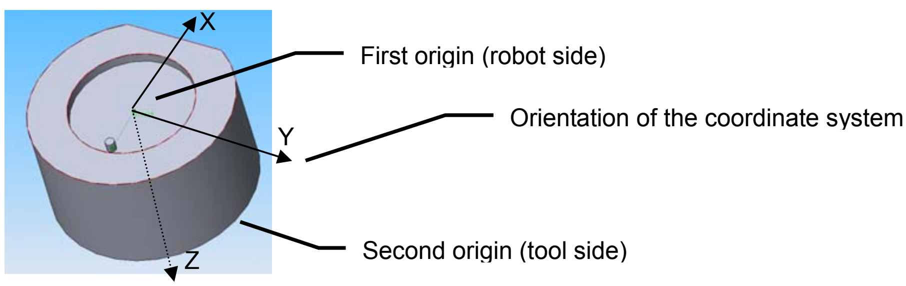


Fig. 4-1 Example of Part Creation 1 (In the Case of ATC Master)

4.3.2 Example of Part Creation 2

As a rule, the coordinate system (**Orig***) is set such that the direction away from the robot origin is defined as +Z. If the coordinate system is set in the opposite direction, the direction of connection is also reversed.

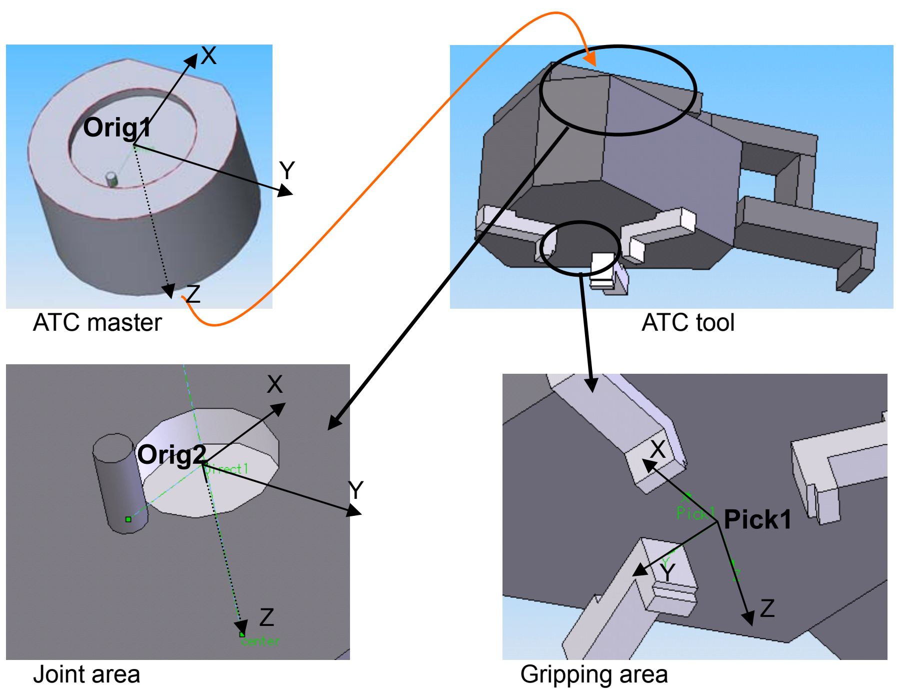


Fig. 4-2 Example of Part Creation 2 (In the Case of ATC Tool)

4.3.3 Example of Part Creation 3

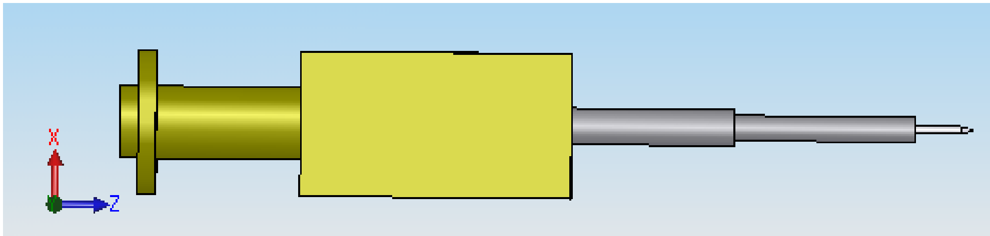


Fig. 4-3 Entire Hand

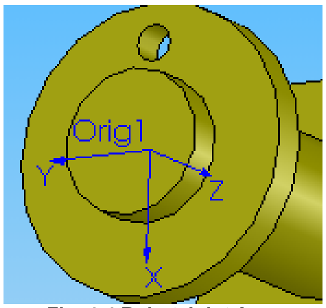


Fig. 4-4 Robot Joint Area

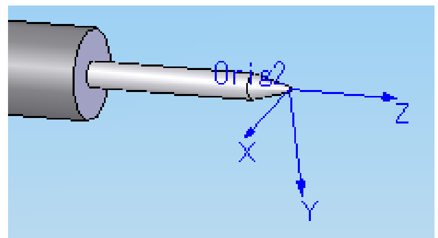


Fig. 4-5 Hand Processing Area

4.4. Workpiece Design

In order for a part to be recognized as a workpiece, append the character string "_Work" to the part name according to the parts creation rules. Also, place an "**Orig1**" marking if the gripping posture is determined.

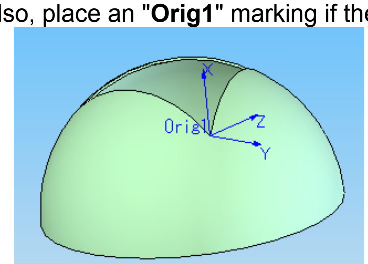


Fig. 4-6 Example of Workpiece Creation

4.5. Travel Base Design

In order for a part to be recognized as a travel base, place a marking (with an arbitrary name) indicating the origin of the travel base. It is also possible to allocate several robots by placing multiple markings on one travel base.

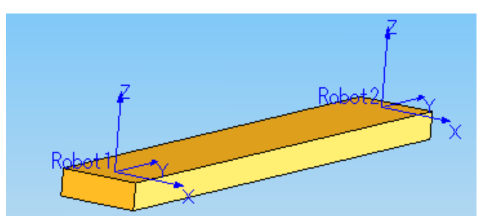


Fig. 4-7 Example of Travel Base Creation

5. Starting and Closing

5.1. Starting MELFA-Works

Start SolidWorks from the [Start] menu of Windows or Desktop icon.
After starting SolidWorks, select [Start] from the [MELFA-Works] menu to start MELFA-Works.

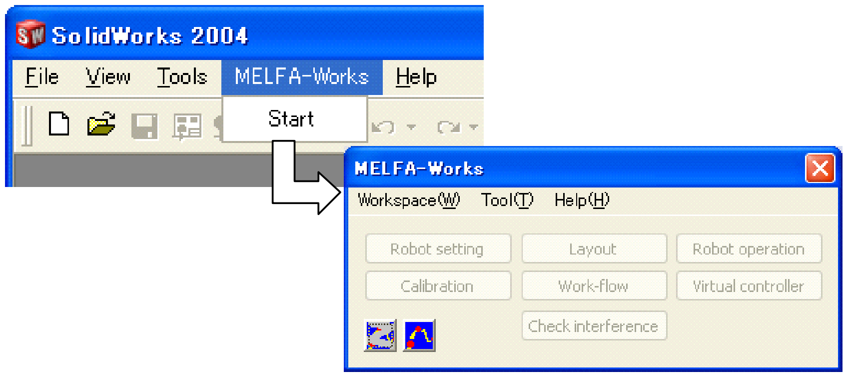


Fig. 5-1 Starting MELFA-Works

5.2. Main window

The MELFA-Works Main window provides workspace operation functions as well as functions for starting various function dialog boxes and switching path displays. By clicking the appropriate function button, the corresponding dialog box for performing robot settings, layout changes, robot operations, calibration, work flow creation, virtual controller control or interference check appears. By clicking the trajectory display buttons, it is also possible to switch between trajectory display ON and OFF or to delete previously displayed paths.

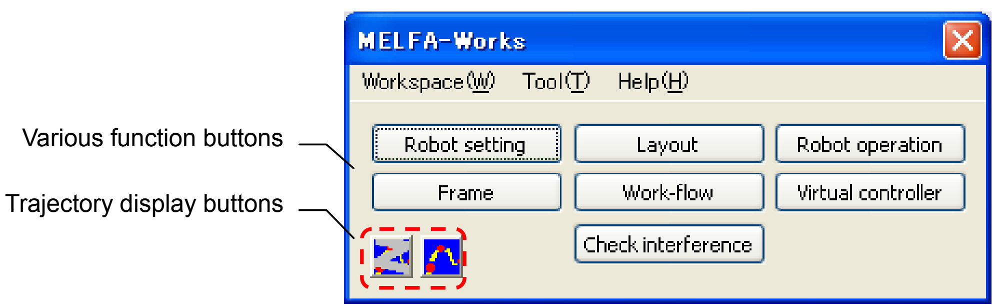


Fig. 5-2 Main Window

Table 5-1 Operations Provided by the Main Window

Item	Explanation
Robot setting	Change settings of robot model, travel base, hand and so on.
Layout	Place the robot and peripheral devices.
Robot operation	Change robot postures.
Frame	Edit frame data.
Work-flow	Edit robot movement points, path and flow.
Virtual controller	Operate the virtual controller.
Trajectory display	Switch between erace trajectories(left button) and showing/hiding trajectories(right button).
Check interference	Check whether or not a robot, hand, tool, workpiece, etc. are interfering.

5.3. New Creating and Loading Workspace

MELFA-Works manages robot information, layout information, movement information, etc. collectively in units called projects. New create or load a workspace from the [Workspace] menu of MELFA-Works.

(1) [New] menu
Create a new workspace.
Select [New] from the [Workspace] menu; the New workspace dialog box appears.

[Workspace name] : Enter the name of the workspace *
[Title name] : Enter the title of the workspace
[Workspace path] : Enter the location where the workspace is to be created or select a location in which to create the workspace in the Browse for Folder dialog box.

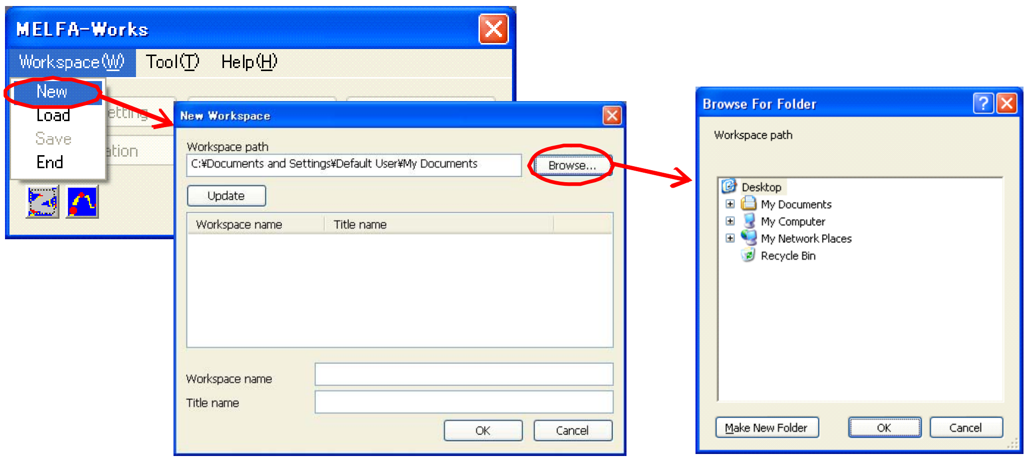


Fig. 5-3 New

*The workspace name becomes an actual folder name.
(The character string that cannot be used for the reserved word of Windows and the folder cannot be used.)

(2) [Load] menu
Load a previously created workspace.
Select [Load] from the [Workspace] menu; the Load workspace dialog box appears.
① The folder that preserves the last workspace is selected by default, and the workspace that has been made is displayed in the list.

② Workspace is selected and the [OK] button is clicked,or workspace is double-clicked, and workspace is opened.

③ The folder path is input to the [Workspace path] text box and the [Update] button is clicked. Or, when [Brows] button is clicked, the [Browse For Folder] screen is displayed. And select the folder where workspace is preserved.

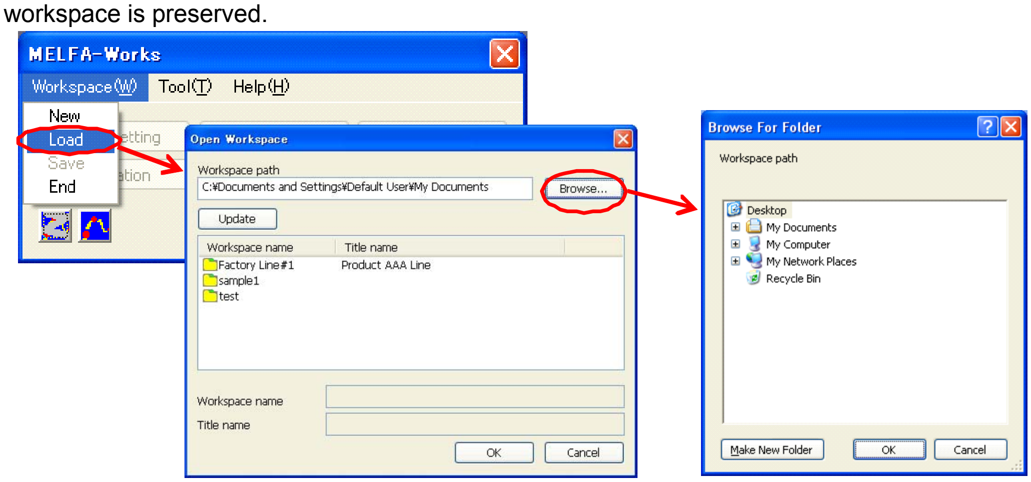


Fig. 5-4 Opening an Existing Project

(3) Select a workspace from history
Select a workspace from the history of workspaces opened in the past.
If you select the [Workspace] menu, up to 10 workspaces that have been opened recently in MELFA-Works are displayed at the bottom of the menu; select a workspace.

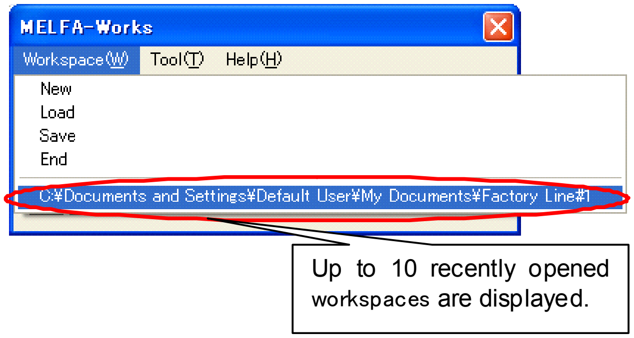


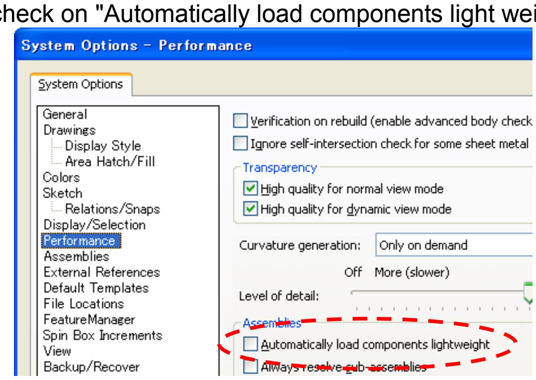
Fig. 5-5 Selecting from History

Tips

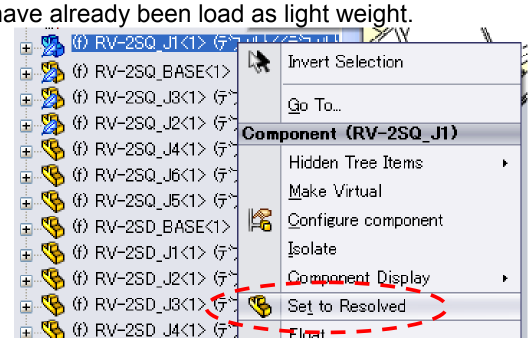
The light weight mode cannot be used.

Please release the following options when parts are load in the light weight mode. Parts of the light weight mode cannot be treated with MELFA-Works.

Please select [tool]-[option]-[performance] from the menu of SolidWorks, and remove the check on "Automatically load components light weight".



Please right-click in parts, select "Set to Resolved", and release the light weight to parts that have already been load as light weight.



5.4. Saving Workspaces

To save a workspace, select [Save] from the [Workspace] menu. Completion message is displayed.

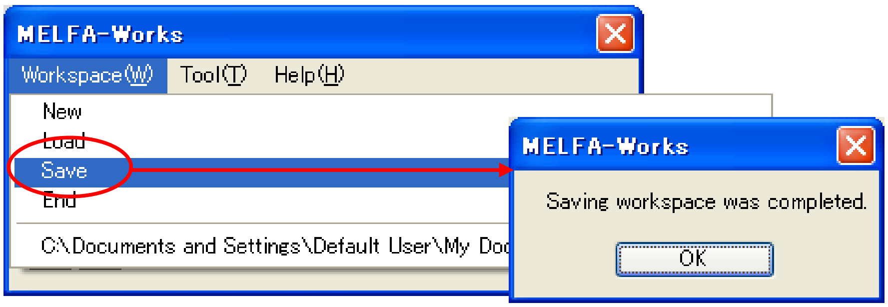


Fig. 5–6 Saving Workspaces

The workspace management message confirming whether or not to save the workspace appears when closing MELFA-Works, creating a new workspace and loading a workspeace as well.

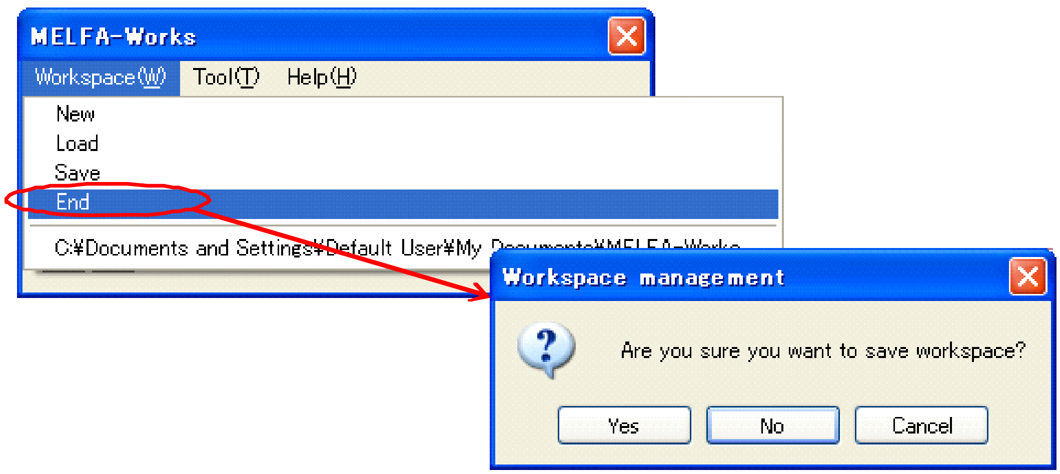


Fig. 5–7 Saving Workspaces

5.5. Import projects

This function can load the project made by an old version.

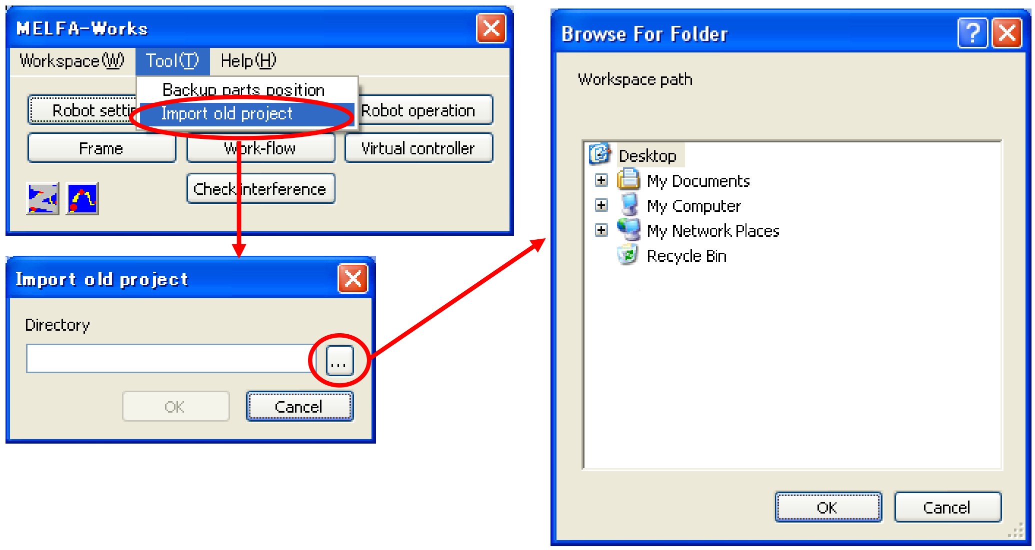


Fig. 5–8 Import old project

Procedure of import

① Select [Import] from the [Tool] menu.

② [Import old project] dialog box is displayed. The old project path is input to the [Directory] text box. Or, […] button is clicked and [Browse For Folder] screen is displayed. This screen can select old project path.

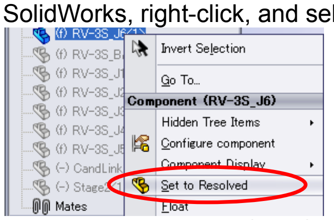
③ When import is completed, the completion message is displayed.

(*When import is done with workspace opened, it is necessary to note the workspace that is opening now is overwrited.)

Tips

About "Set to Resolved" of parts after import

SolidWorks cannot find the positions of parts after import, and parts might not be displayed. In this case, parts are suppressed it. Please select parts from the [Feature Manager] of SolidWorks, right-click, and select [Set to Resolved].



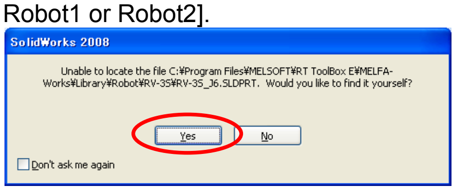
Please select [Yes] if the following messages are displayed.

The next

・The preservation places of common parts are specified.

・A necessary parts for the project folder are copied, and the project folder is specified.

Please execute either. Parts of the robot are copied onto the project folder[MELFA-Works＼Robot1 or Robot2].



6. Robot Setting

In MELFA-Works, it is possible to set up to 8 robots of the types indicated in "**Table 1-1 Robots that can be Used(CRn-500 series)**". In the Robot setting dialog box explained in this chapter, it is possible to load robots, attach and remove hands and travel bases to/from each robot and make hand signal settings to be used in simulation.

In order to make robot settings, double-click a target robot from the list in the Robot setting dialog box, or select a robot and then click the [Change] button, to display the Robot details setting dialog box.

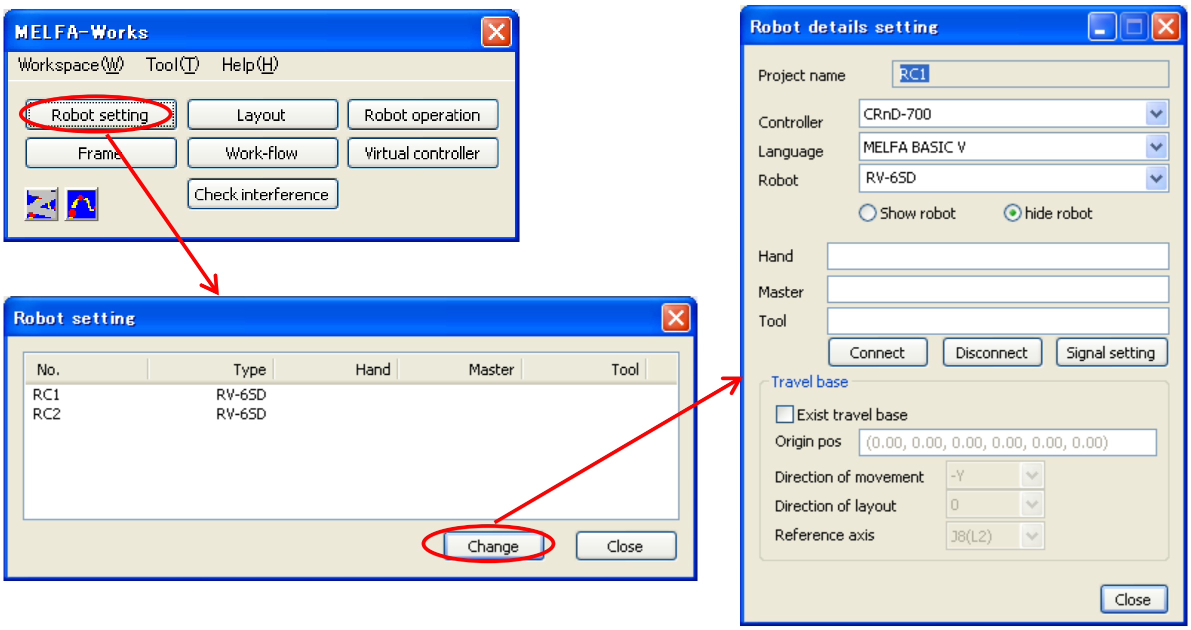


Fig. 6-1 Robot Setting

Layout after selecting a robot model is performed in the Layout dialog box, which is explained in Chapter 7.

⚠ CAUTION

About the number of the robot

MELFA-Works can treat eight robots in the specification. However, the performance changes greatly by the performance and the state of the load of the personal computer that uses it.
Please use it with one so that the decrease in the performance may influence the calculation of the cycle time when you calculate the cycle time.

Moreover, the calculated cycle time is not completely corresponding to the cycle time of a real robot. Please use the result as a reference value.

6.1. Selection of robot model

Select the robot model in the following procedure.

① The controller type to set the model is selected from [Controller] of “Robot details setting” window.

② After controller type is selected, Robot type is selected from [Robot].
The confirmation message is displayed when Robot type is already selected and it has been displayed on the screen.

③ [Show robot / Hide robot] radio button is switched to [Show]. When [Hide robot] is selected, Robot model on the screen disappears.

④ A confirmation message is displayed. If the model is correct, click [Yes] to load the robot.

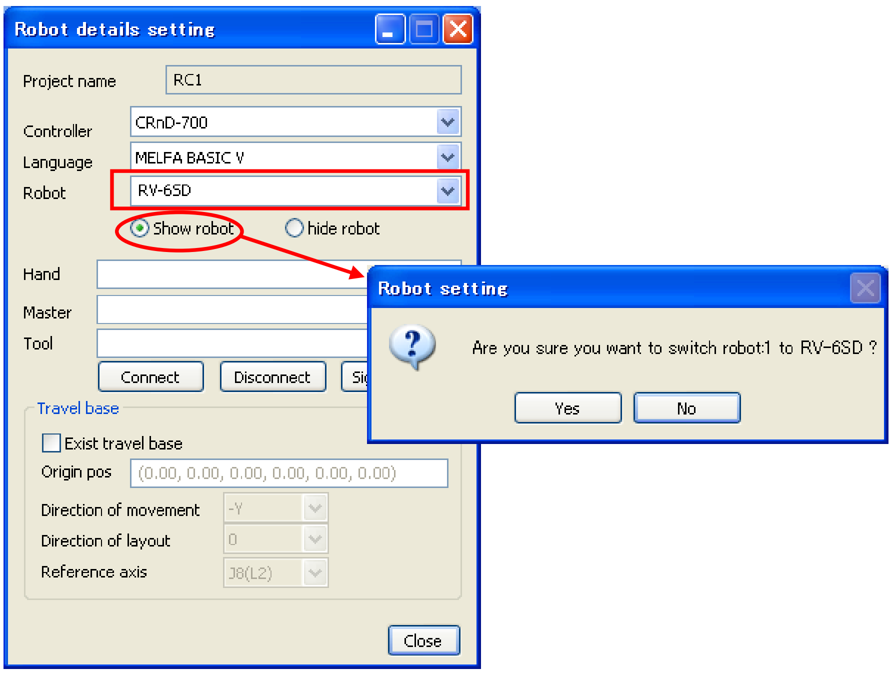


Fig. 6-2 Robot Model Setting

Memo

If using 2 robot units

Robots are placed at their CAD origin points when loaded, so 2 connected robot units might be placed overlapping each other when loaded. To avoid this, first place peripheral devices containing coordinates showing the robot installation position and then place the robots one at a time on the coordinate system. This makes it easy to find the relative positions and makes the task proceed more efficiently. See the next chapter for information on changing placement positions.

6.2. Attaching Hands

Attach hands to a robot. Note that parts must adhere to several rules in order for them to be used as hands. See “Chapter 4 Creation of Parts" for the details.
Load hands to be attached in advance by dragging and dropping them onto SolidWorks window, or using other method.
There are the following two ways to attach hands. First, load the hand to be installed by drag & drop or similar method onto the SolidWorks screen.

Method 1: Select a hand in SolidWorks and click the [Connect] button.

- Fixed hands and ATCs are automatically identified and attached.
- If a hand has already been attached, it is removed.

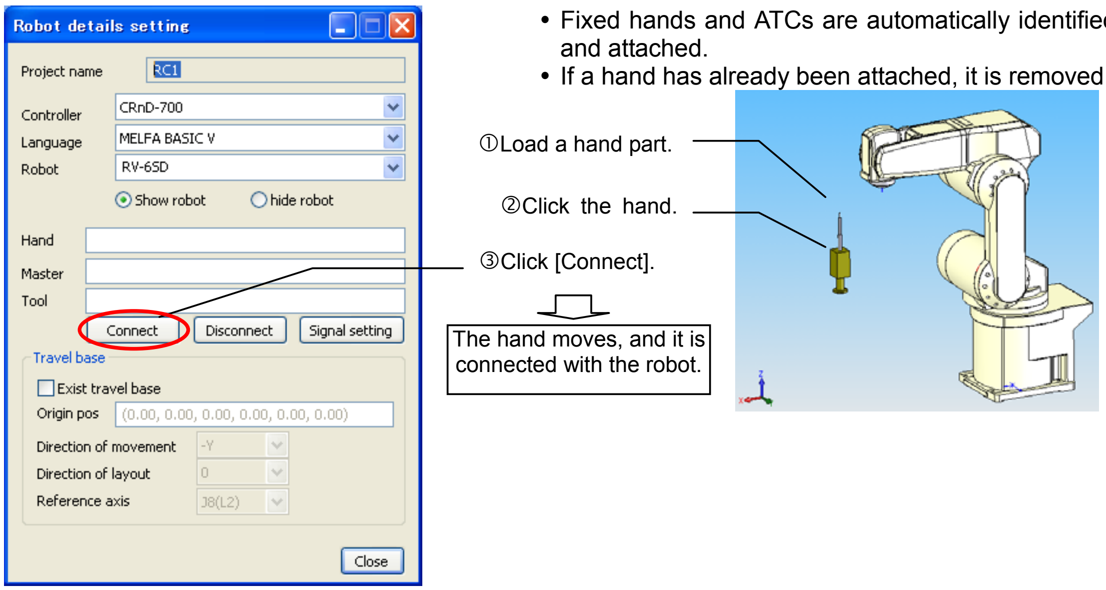


Fig. 6-3 Attaching Hand 1

Method 2: Select the [Hand] text box and click a hand part.

- Only the specified type of hand is attached.
- If a hand has already been attached, it is removed.

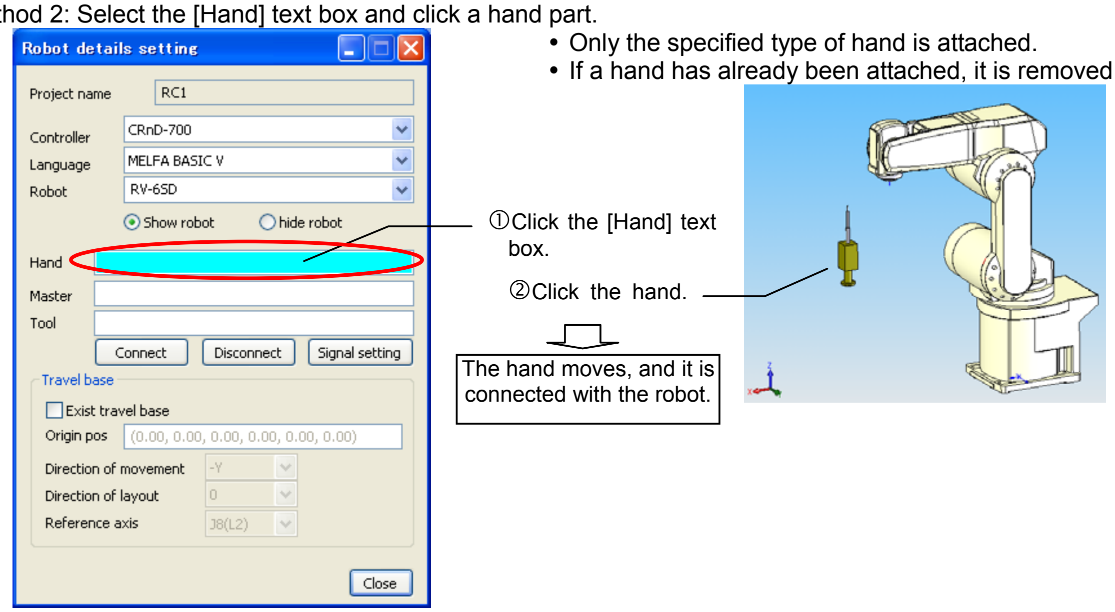
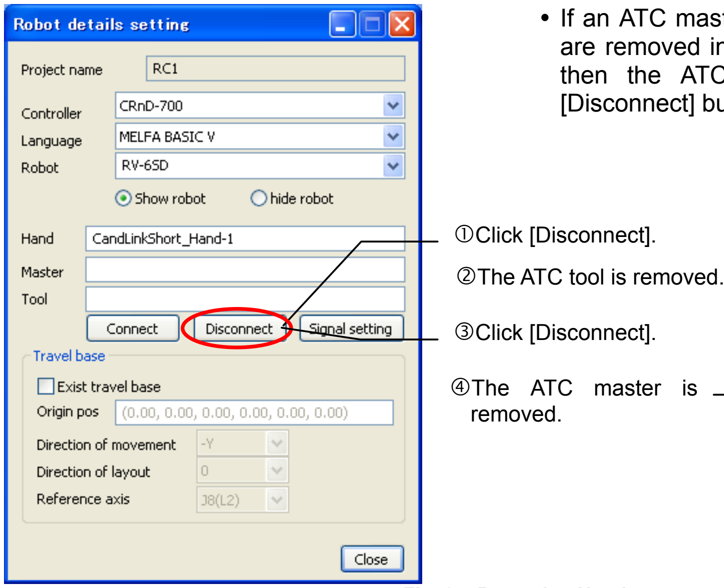


Fig. 6-4 Attaching Hand 2

6.3. Removing Hands

The hand currently attached to the robot is removed by clicking the [Disconnect] button.

- If an ATC master and ATC tool are mounted, they are removed in the order of the ATC tool first and then the ATC master with each click of the [Disconnect] button.



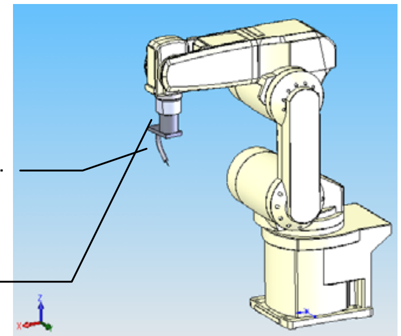


Fig. 6-5 Removing Hand

6.4. Setting Hand Input/Output Signals

When simulating a robot program, MELFA-Works also allows simulating movement in the vicinity of the hands, such as ATC attachment/removal and workpiece grip/release. These movements can be controlled by input/output signals of the virtual controller and signals and movements around hands can be associated in the Hand I/O dialog box.

Click the [Signal setting] button in the Robot details setting dialog box to display the Hand I/O dialog box.

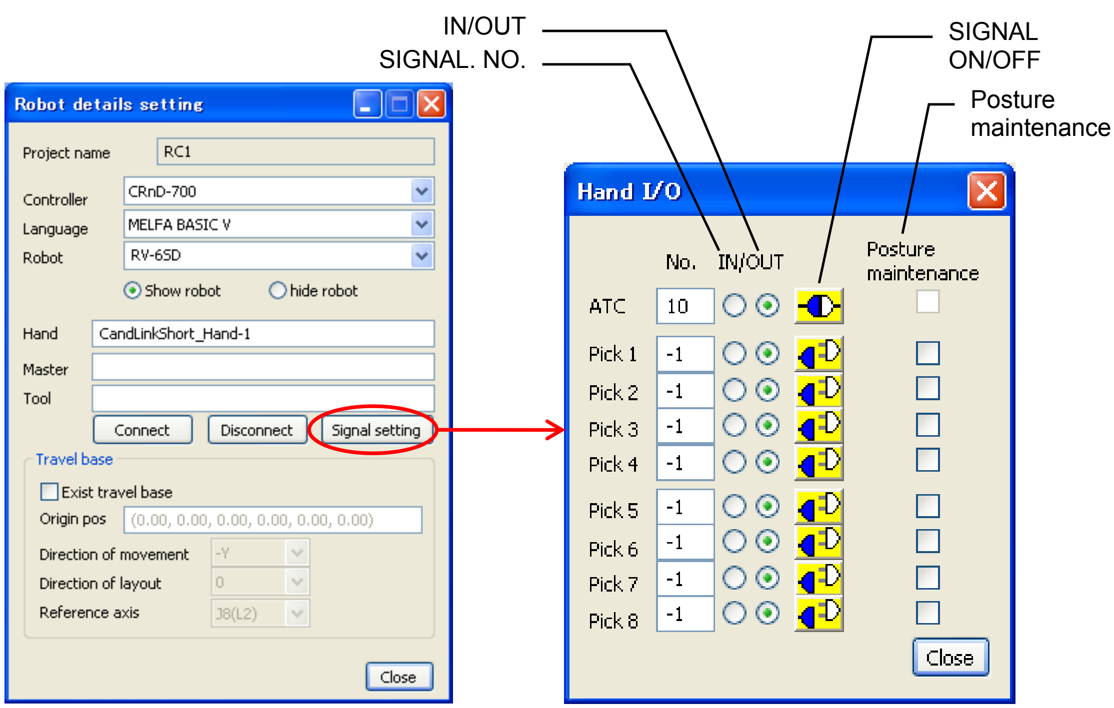
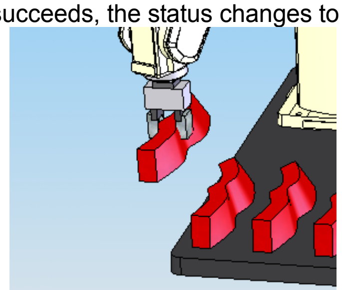


Fig. 6-6 Hand I/O Dialog Box

Table 6-1 Details of Operation in the Dialog Box

Item	Explanation
SIGNAL. NO.	Sets the signal No. assigned to the robot hand. Here, “ -1” indicates that no setting was made. Creating a robot program to output the signals set here, allows controlling work clamp/unclamp and ATC connect/disconnect during robot simulations. Specify a signal number. Specification of -1 means not set. [ATC]: Connected signal of the ATC master and ATC tool. [**Pick***]: Connected signal of a gripping hand and workpieces. * Attaches/grips at a rising edge and removes/releases at a falling edge.
IN/OUT	Select either input signal or output signal for a robot. IN: Simulates changes of an input to a robot, i.e., M_IN(n). Corresponds to cases where an external device (PLC, etc.) controls the robot hand. OUT: Simulates changes of an output from a robot, i.e., M_OUT(n). Corresponds to cases where the robot hand is controlled by a robot program.
SIGNAL ON/OFF /	Simulate turning a signal ON/OFF. : Indicates that the hand is attached. Click the button in this display status to simulate removal of the hand. : Indicates that the hand is removed. Click the button in this display status to simulate attachment of the hand. In hand attachment operations, ATC tools**(Orig1)** in the vicinity of the ATC master**(Orig2)** and workpieces**(Orig1, or origin point)** in the vicinity of a gripping hand**(Pick*)** are attached/gripped(within 200 mm). If the action succeeds, the status changes to the status.  * If a signal number has not been specified, neither attachment nor removal is simulated.
Posture maintenance	Specify whether or not to maintain the posture at gripping. Maintain : Shifts to maintain the positional relation between the hand and work while gripped or clamped. Do not maintain : Grips such that the hand’s **PickN** and the **Orig1** coordinate system of a workpiece are matched at gripping. It is possible to take a fixed gripping posture regardless of the gripping position.

6.5. Setting Travel Base

MELFA-Works allows placing a robot on a travel axis created in SolidWorks and moving it with a robot program or robot operation. The travel location can be specified either by "relative position" with the coordinate system on a part as the origin or "absolute position" with coordinates on the CAD coordinate system as the origin.

Load a travel base part into an assembly and clicked [Exist travel base] check box on the Robot detail setting window.

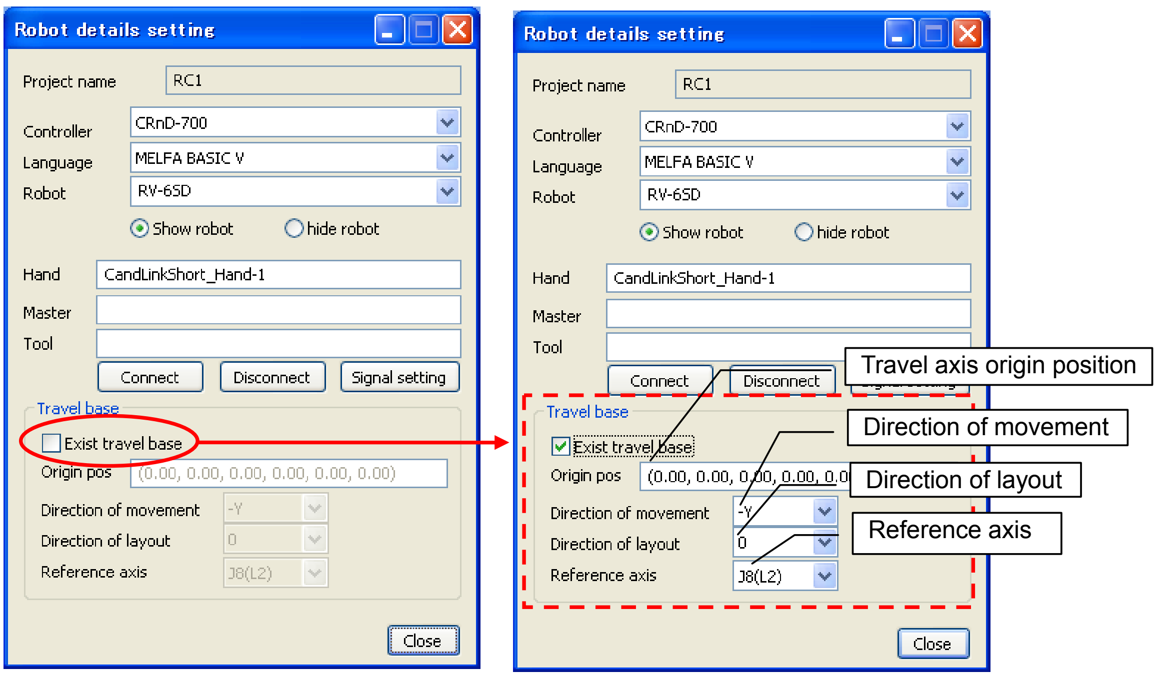


Fig. 6-7 Travel Base Setting Section

Table 6-2 Details of Operation in the Dialog Box

Item	Explanation
Origin pos Origin pos (0.00, 0.00, 0.00, 0.00, 0.00, 0.0	[Name of coordinate system] or [Coordinate value] can be specified for Travel axis origin position. **For Name of coordinate system** [Origin pos] is clicked. And [Name of coordinate system] used as [Travel base] is clicked. **For Coordinate value** [Position] in [CAD coordinates] can be specified directly by inputting [Coordinate value (0,0,0,…)].
Direction of movement Direction of movement +Y	Specify in which direction of the coordinate system set for the travel axis origin the axis moves if the reference axis moves in the positive direction. Make selection from +X, -X, +Y and -Y (default value: +Y).
Direction of layout Direction of layout 0	Specify the orientation of the robot with respect to the coordinate system set for the travel axis origin. Make selection from 0, 90, 180 and -90 degrees (default value: 0 degrees).
Reference axis Reference axis None	Specify which axis of the robot is set as the travel axis. Make selection from Nothing, J7 and J8 axes (default value: Nothing).

7. Layout

With MELFA-Works, it is possible to use the Layout dialog box to specify positions of robots and peripheral devices such as travel bases relative to the CAD software origin as well as robot origin, part origin and arbitrary coordinate systems.

Specify layout by specifying positions relative to the base position.
The base position can be selected from the following 4 types.

- Origin
- Origin of other robots
- Origin of other parts
- Coordinate system

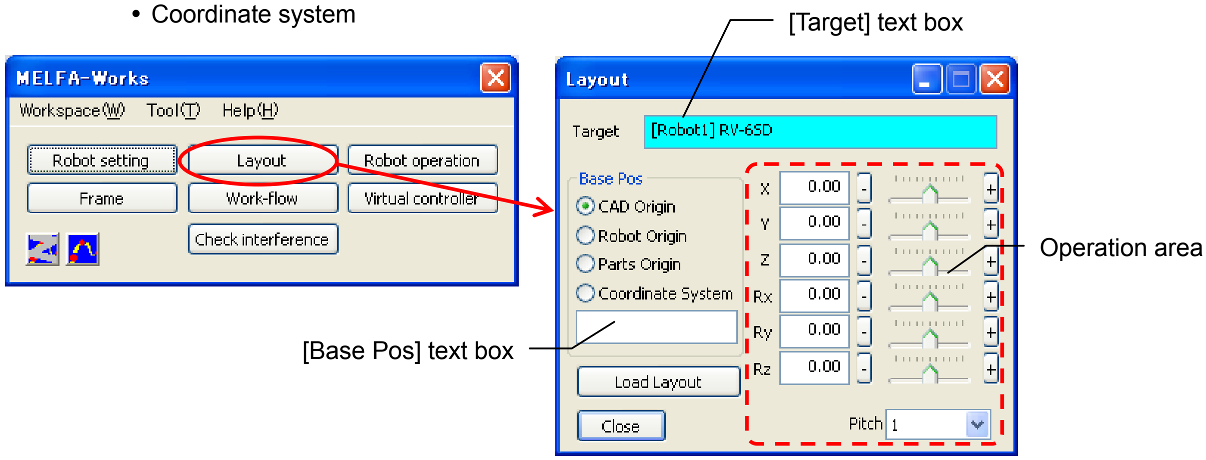


Fig. 7-1 Changing Robot Layout

Layout changes are achieved by the following procedure.

① Click the [Layout] button from the Main window to display the Layout dialog box.
② Select the [Target] text box and click a robot, peripheral device, etc. to display the name of the robot or part you selected in the [Target] text box.
③ Select the base position. If you select a position other than an origin, click the [Base Pos] text box and click the robot, part or coordinate system. In the same way as for the [Target] text box, the selected name is set in the [Base Pos] text box.
④ Operate in the Operation area to determine the position.
It is also possible to load layout data by clicking the [Load Layout] button.

CAUTION

A robot placed on a travel base must move the travel base.

A robot placed on a travel base cannot be moved because its position relationship with the travel base is fixed. In this case, specify the travel base as the target of movement to move the robot along with the base.

Tips

After loading peripheral devices, let's place a robot.

It is possible to work efficiently by create the coordinate system on the peripheral devices beforehand, and place the robot in the coordinate system. SolidWorks functions can also be used for layout of products not controlled by MELFA-Works such as hands not connected to robots or peripheral devices.

7.1. Positioning Robots in Peripheral Device Coordinate Systems

Follow the procedure below to position a robot in a coordinate system of a peripheral device.

① Display the appropriate coordinate system via the menus of SolidWorks.

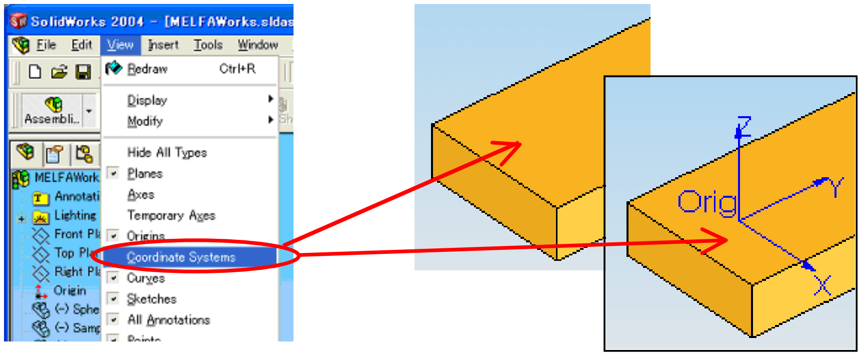
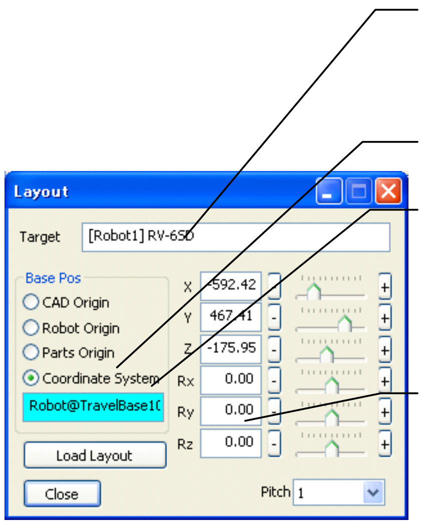


Fig. 7-2 Coordinate System Display



② Click this input area to set to selected state. Selecting the robot in this state displays the robot name that was clicked.

③ Select the desired "Coordinate System" here.

④ Click this input area to set to selected state. Clicking "Coordinate System" on "SolidWorks" in this state, displays the coordinate system name that was clicked and shows the relative position from these coordinates to the robot hand in the coordinate box.

⑤ Setting all coordinates to "0" places the robot at a matching position on the coordinate system. Can also move by moving slider or specifying pitch with the "-/+" keys.

Fig. 7-3 Layout on Peripheral Device Coordinate System

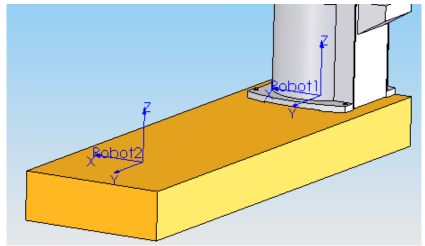
⑥ Lastly, hide the coordinate system again via the menus of SolidWorks.

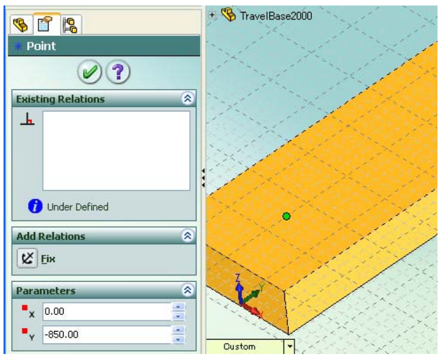
Tips

To place a robot on a peripheral device, create a coordinate system for the peripheral device in advance.

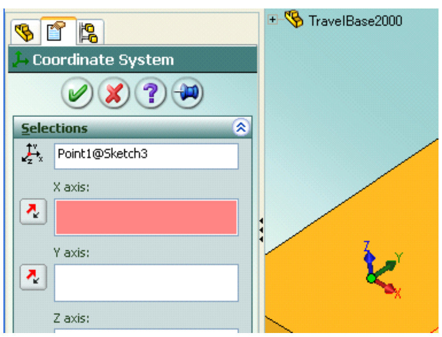
To place a robot on a peripheral device, create a coordinate system at the layout position.

Here is an example for forming coordinates using SolidWorks.



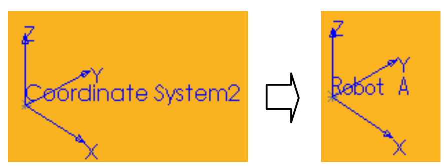


①Open the product file where you want to embed coordinates, and set "Insert sketch" on the surface where you want to embed the coordinates. Add "points" to the sketch, and set the desired coordinates.



②Select the "Coordinate System" from "Reference Geometry" and set the point formed in ①. Set the direction if needed.

③Change the coordinate system name.



7.2. Backup parts position

Posture and work of robot is preserved and can be restored. Moreover, the comment when preserving it can be set.

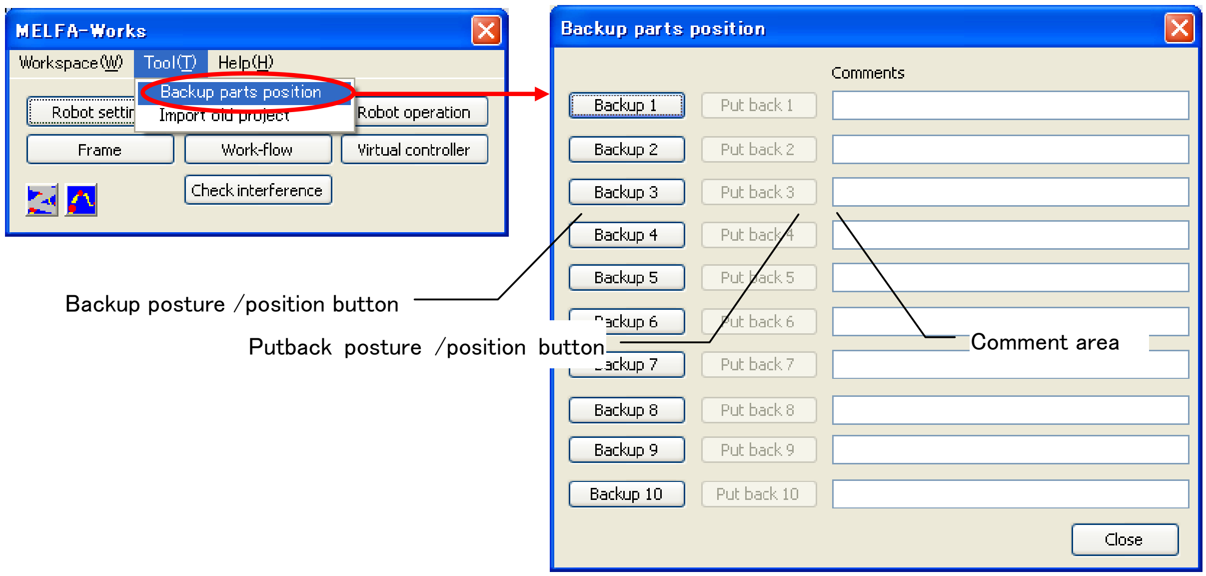


Fig. 7-4 Backup parts position

Backup parts position is executed in the following procedures.
① Select [Backup parts position] from the [Tool] menu.
② Select robot that want to preserve position. And [Backup1] ~ [Backup3] button is clicked.
③ The confirmation message is displayed. And [Yes] is clicked.
④ Please input comments if necessary.

7.3. Put back parts position

The preserved parts position is restored. However, parts deleted after the parts position is preserved are not restored.

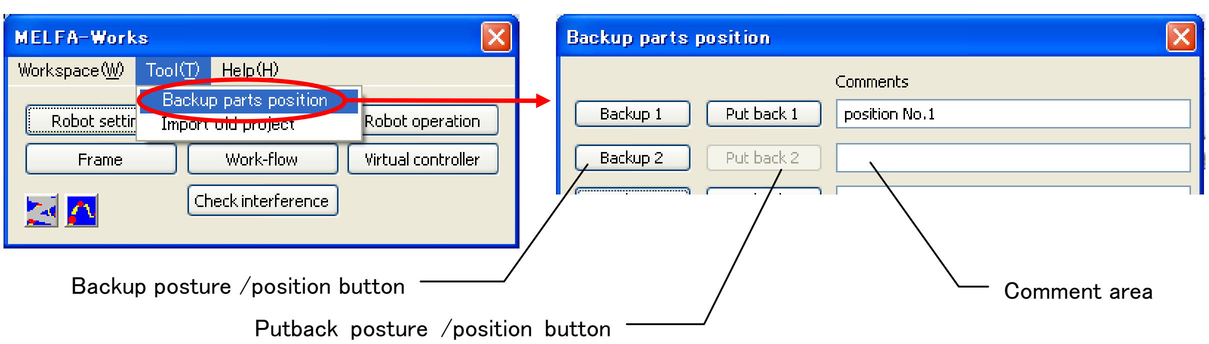


Fig .7-5 Putback parts position

Putback parts position is executed in the following procedures.
① Select [Backup parts position] from the [Tool] menu.
② [Putback1] ~ [Putback3] button is clicked.
③ The confirmation message is displayed. And [Yes] is clicked.

8. Robot Operations

Use the Robot operation dialog box to operate the posture of the currently loaded robot. The robot posture can be specified by XYZ coordinates or joint coordinates.
The range of joint movements is limited so some postures might be impossible to reproduce on the actual unit. Finally, connect with a virtual controller, and confirm the operation.
(Unlike in the JOG Panel, which controls the virtual robot controller (refer to “Chapter 16.JOG Panel”).)
The set conditions can be checked on the window.

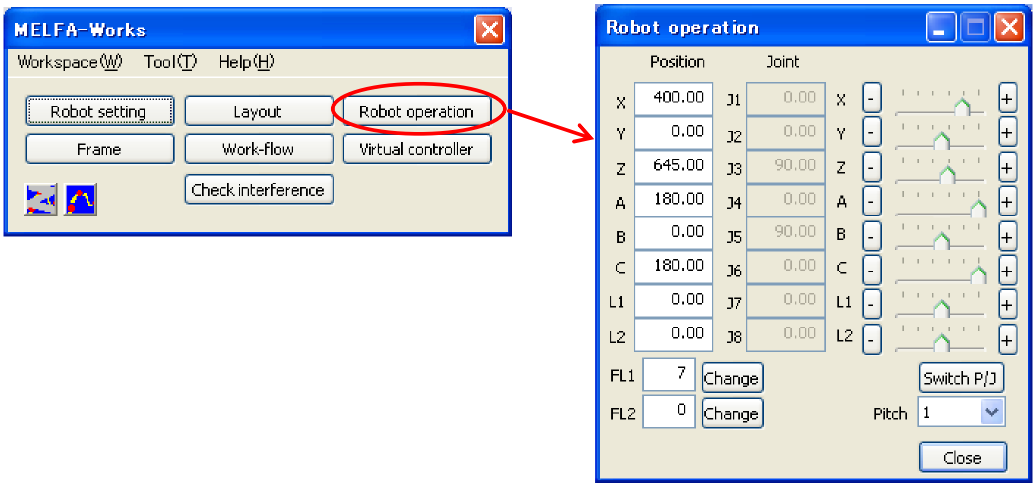
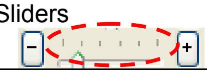
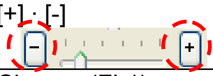
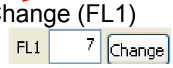
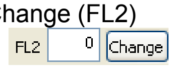
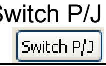
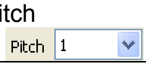


Fig. 8-1 Robot Operation

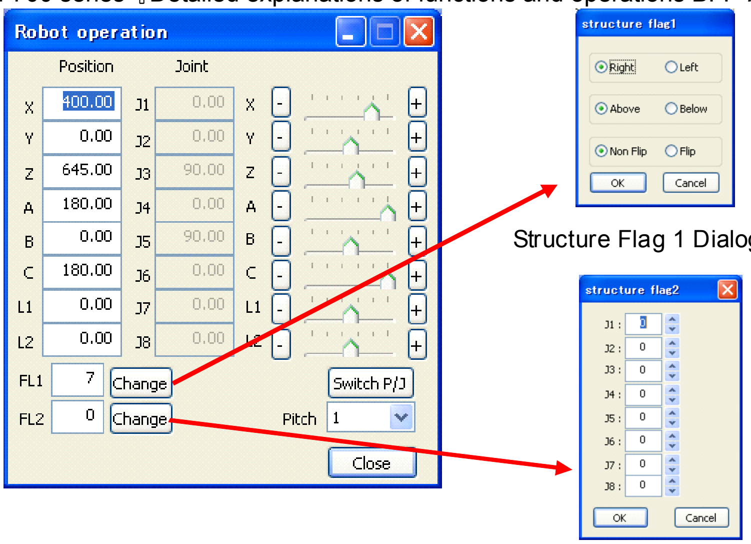
① Click the [Robot operation] button from the Main window to display the Robot operation dialog box.
② Use the [Switch P/J] button to switch operation methods between Position (XYZ) and Joint.
③ Change the robot posture using one of the following methods.
  (1) Move in increments of one pitch by clicking the [-]/[+] buttons. The unit of movement is selected from the [Pitch] box.
  (2) Use the sliders to change the posture.
  (3) Enter coordinate values directly to move the robot.
  (4) In the case of Position (XYZ) coordinates, specify FL1/FL2 as necessary. The details are explained in “8.1 Flag Setting Dialog Box”.

Table 8-1 Details of Operations in the Dialog Box

Item	Explanation
[X] ~ [C], [L1] ~ [L2]	Display the current values of the XYZ coordinates. It is also possible to enter coordinate values directly.
[J1] ~[J8]	Display the current values of the joint coordinates. It is also possible to enter coordinate values directly.
Sliders 	Increase/decrease each coordinate value rapidly.
[+]・[-] 	Increase/decrease each coordinate value in the unit selected by [Pitch].
Change (FL1) 	Click the [Change] button to display the structure flag 1 (F1) dialog box, in which the value of the structure flag can be entered directly as a numerical value.
Change (FL2) 	Click the [Change] button to display the structure flag 2 (F2) dialog box, in which the value of the multi-rotation flag can be entered directly as a numerical value.
Switch P/J 	Switches the coordinate systems (XYZ/joint).
Pitch 	Select the unit of values increased/decreased by the [+] and [-] buttons.

8.1. Flag Setting Dialog Box

In case of the Position (XYZ) coordinate, it is possible to specify the structure flag (FL1) and multi-rotation flag (FL2).
In the structure flag 1 dialog box, specify Right/Left, Above/Below and Non Flip/Flip.
In the structure flag 2 (multi-rotation flag) dialog box, specify the multi-rotation information of each axis.
See the instruction manual for the robot unit for more information on the structure flag and multi-rotation flag.
CRn-500 series 『Detailed explanations of functions and operations BFP-A5992』
CRn-700 series 『Detailed explanations of functions and operations BFP-A8661』



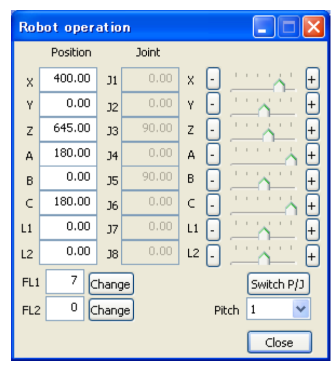
Structure Flag 1 Dialog Box

Structure Flag 2 (Multi-rotation Flag) Dialog Box

Fig. 8-2 Flag Setting Dialog Box

8.2. Movement to a Click position

When processing system (The coordinate system "Orig2" is set) hand is installed, it is possible to move to the clicked position on parts. The robot moves to the position in which the click point is indicated if the movement posture is in the range of motion of the robot when corner/edge/face on parts is clicked with "Robot operation" screen displayed.



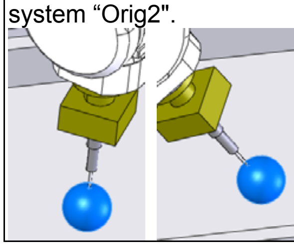
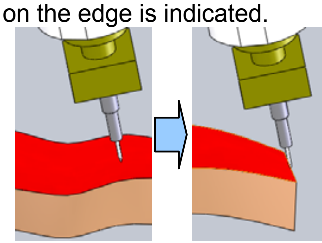
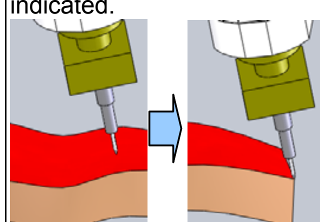
Face	Edge	Coner
The robot moves to the position in which the click point on the face is indicated. At this time, it changes one's posture as the normal at the click position is corresponding in the direction of Z of coordinate system “Orig2”. 	The robot moves with posture kept positional in which the click point on the edge is indicated. 	The robot moves with posture kept positional in which the corner is indicated. 

Fig. 8-3 Moving to a Click position

9. Frame

The frame is a coordinate system in CAD space. The frame is used for the following usage.

* Because the usage was expanded, the name has been changed to "Frame" though the name of this chapter was "Calibration" even in Ver.3.3.

(1) CAD space and a real space the position are matched at the calibration.
The frame of a real space corresponding to the frame made on MELFA-Work is taught with the robot. MELFA-Works is corrected by using the difference of these two frames.
※Only multi-point data can be calibrated. Teaching points cannot be calibrated.

(2) A relative position of the off-line teaching result is output.
MELFA-Works is output at a relative position from the frame that specifies the off-line teaching point.

The tasks involved in calibration on the personal computer side are categorized into tasks related to MELFA-Works main body and tasks related to the calibration tool (Integrates RT ToolBox2) as follows.

MELFA-Works main body → Data creation for calibration
Calibration tool → Calibration using the data

This chapter explains how to create data for calibration to be used by the calibration tool. The calibration tool is explained in “Chapter 17 How to Use the Calibration Tool”.

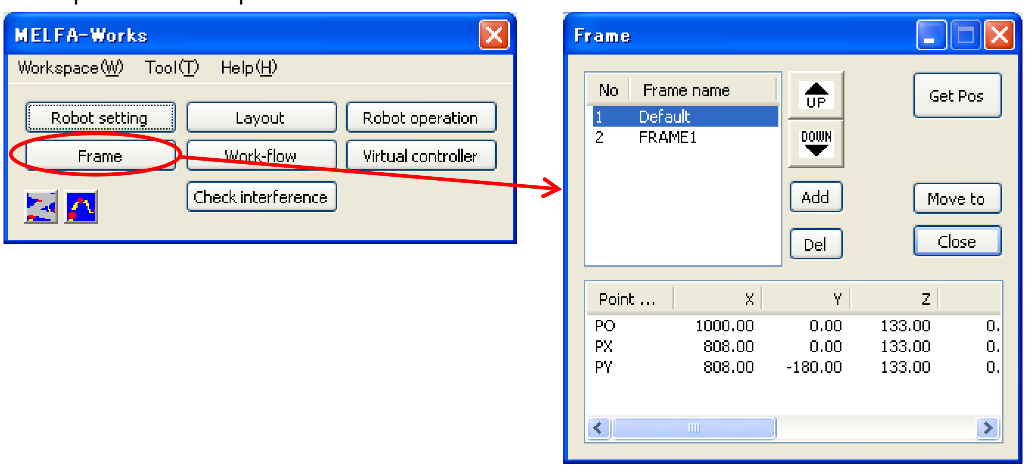
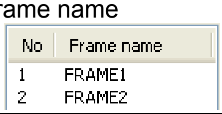
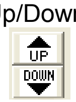
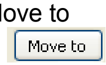
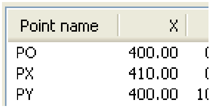


Fig. 9-1 Calibration Dialog Box

Table 9-1 Details of Operations in the Dialog Box

Item	Explanation
Frame name 	Displays a list of frames that have been created. The items displayed are calibration No. and frame name. Double-click an item in the list to display the frame name input dialog box, and change the corresponding frame name.
Up/Down 	Click these buttons to change the position of the frame data selected in the frame name list up/down.
Add 	Adds new calibration data. Frame name is automatically attached when frame data is added. It is added prior to the selected line if frame was selected or added at the end if not selected. The attached name can be changed.
Del 	Deletes frame data selected in the frame name list.
Get Pos 	Acquires the coordinates of the point indicated by the robot hand and stores them as the specified point (PO/PX/PY) of the selected frame data.
Move to 	Moves the robot to the posture where the robot hand indicates the specified point (PO/PX/PY) of the selected frame data.

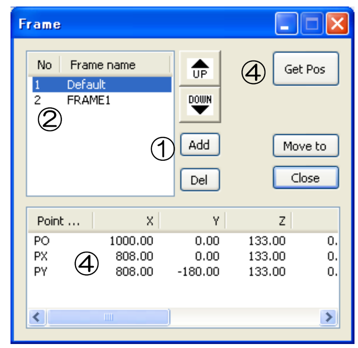
Item	Explanation
Point list 	Displays a list of frame data points selected in the frame name list. The [Get Pos] and [Move to] buttons operate on the points selected in this list. It stores coordinate values of 3 points used in frame. Note that the positions of the 3 points "must not be on a straight line." Also, as these points are taught to a robot, they must be set within the robot movement range.

9.1. Frame Data Creation Procedure

Frame data refers to a data set consisting of 3 points that satisfy the following conditions.

- They have clear position relationships with workpieces.
- They are not on a straight line.
- They can be taught.

MELFA-Works allows specifying multiple frame data sets. For example, if several workpieces exist in the vicinity of a robot, frame can be performed for each workpiece to achieve highly accurate operation.



① Click the [Add] button to add frame data.
② Click the frame from the frame name list.
③ Move the robot to the frame point (refer to "8.2 Movement to a Click po").
④ Select the coordinate data (PO, PX, PY) and click the [Get Pos] button to acquire the position.

Prepare 3 points used for frame data creation in advance to improve the positioning accuracy by the robot. During the frame, these 3 points are taught; be aware that characteristic points such as corners can be taught at higher accuracy.
If 3 points cannot be prepared on a workpiece model, 3 points on a peripheral device such as a workpiece fixing base can also be used, as far as the position relations are clear.

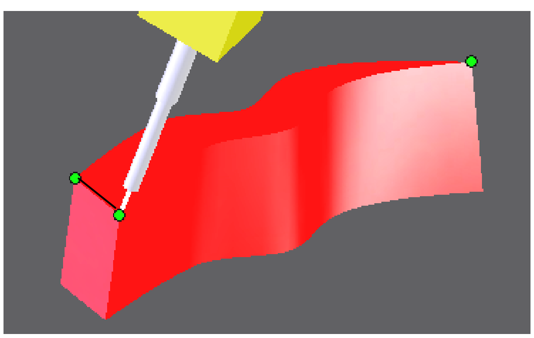


Fig. 9-2 Specifying 3 Points on Workpiece

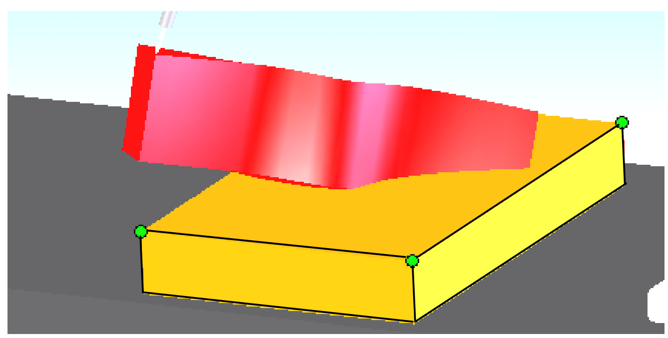
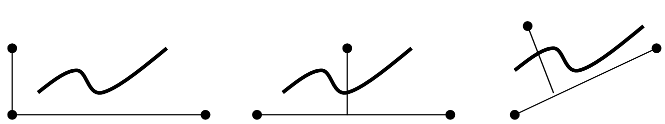


Fig. 9-3 Specifying 3 Points on Workpiece Fixing Base

⚠ CAUTION

About calibration

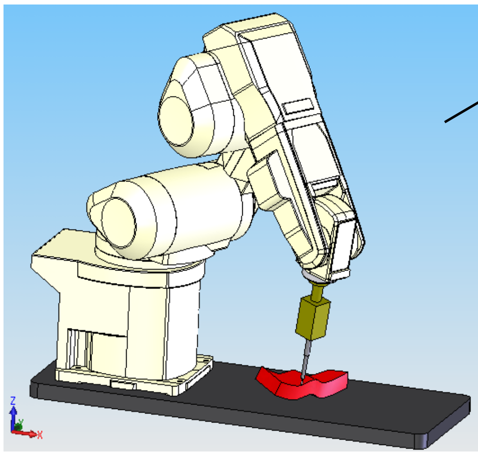
In order to move the actual robot with high accuracy, the accuracy of calibration is important. "3 points that are not on a straight line" are required for teaching during calibration. These 3 points should preferably be located at some distance from each other, rather than very densely together, in order to improve the accuracy. Distances cannot be collectively set due to the work size and robot coordinates but can be set in a trace area by using the CAD link function.



9.2. To Perform Highly Accurate Calibration

In order to perform highly accurate calibration, specify the layout of the robot and workpiece position relationship as accurately as possible. It is possible to correct deviance through calibration, but the smaller the difference between the status before and after calibration, the higher the accuracy. It is essential to create conditions that match the actual environment as closely as possible in the CAD software.

To specify the layout of the robot and workpiece position relationship, it is convenient to use the layout function of MELFA-Works (refer to “Chapter 7 Layout”).



Use the layout function of MELFA-Works to create conditions that match the actual environment as closely as possible.

Fig. 9-4 Example of CAD Link Execution

10. Creation of Work Flow

A work flow refers to a series of operations such as moving to point A, carrying out processing along path B and finally moving to point C. In MELFA-Works, such work flows are created and eventually converted to robot programs. Such robot programs contain position data as well as information for tracing along a path; they can be used as templates for programs used in actual systems.

It is possible to add teaching data and path data to a work flow. This chapter explains how to create teaching data, path data and work flows.

The different terms have the following meaning.

Item	Explanation
Teaching data	It is loaded robot posture information. The posture information includes the position/direction at the robot's mechanical interface section and structure flags. The posture/path registration area is used (see "10.1 Creating Teaching Points").
Path data	It is a general term for edges on workpieces and other areas processed by a robot and various conditions such as speed and acceleration/deceleration required for processing. Processed areas are extracted from path data and converted to collective dot sequence data with direction. The posture/path registration area is used (see "10.2 Path Creation").
Work flow	It is a sequence of work tasks created by combining teaching data and path data. A work flow can be converted to a robot program or into dot sequence data. In doing so, the work and work flow registration areas are used (see "10.4 Work Flow Creation").

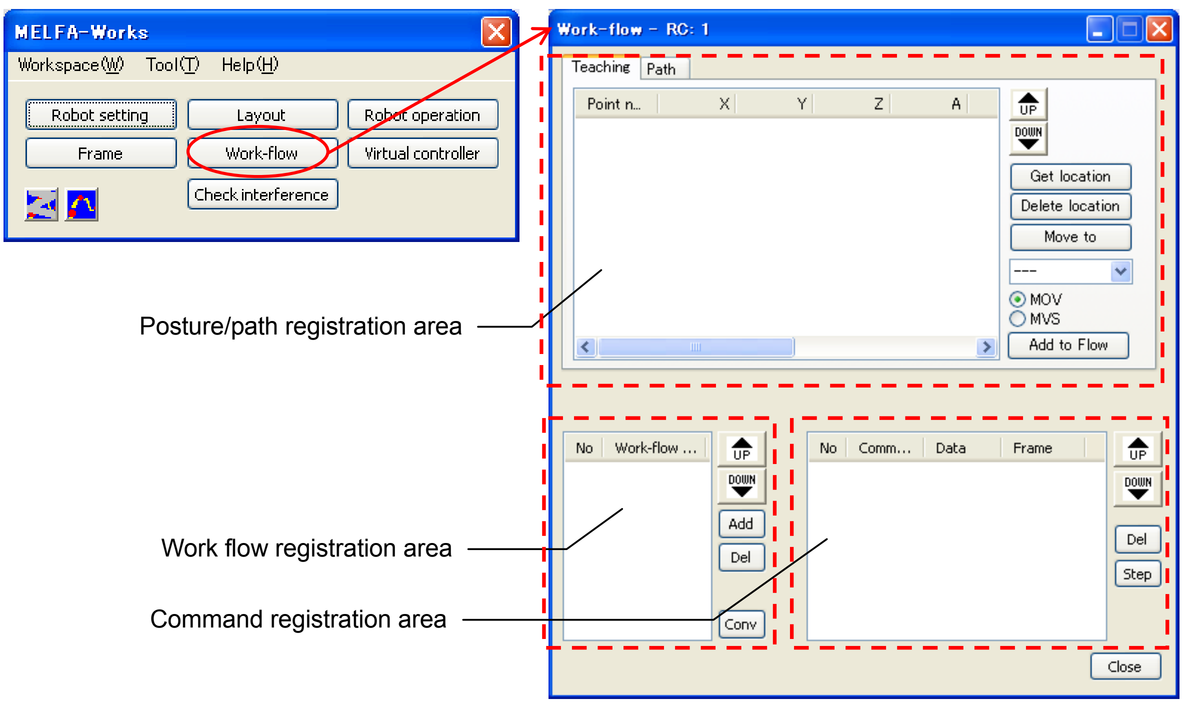


Fig. 10-1 Work-flow Dialog Box

10.1. Creating Teaching Points

Through the use of teaching points, it is possible to store robot postures and subsequently reproduce the postures. Postures stored here can be reflected in the final robot program output by specifying MOV or MVS as the movement method and registering them in work flows.

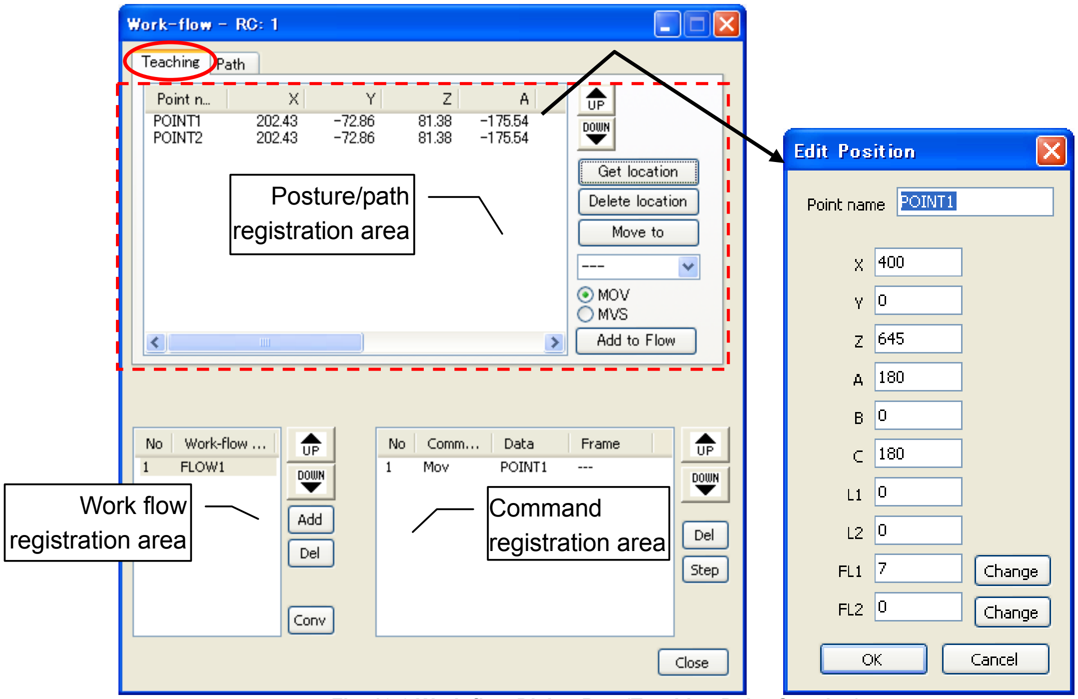


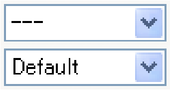
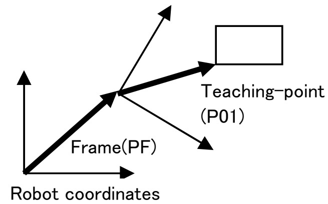
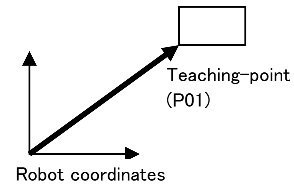
Fig. 10-2 Work-flow Dialog Box (Teaching Point Creation)

Operation procedure

① Change the robot posture in the Robot operation dialog box.
② Click the [Get location] button in the Teaching tab to add the current posture to the list.
③ Select unnecessary postures from the list and click the [Delete location] button.
④ To check a posture, select it from the list and click the [Move to] button.
⑤ Select a method of movement (MOV/MVS) and click the [Add to Flow] button to add the posture to the work flow. The work flow must be created in advance (see “10.4 Work Flow Creation”).

Table 10-1 Details of Operations in the Dialog Box

Item	Explanation
Teaching point list	Names and coordinates of created teaching points are displayed in a list. Double-click an item in the list to display the position data edit dialog box, in which it is possible to edit coordinate values.
UP/DOWN	Move the position of the teaching point selected in the teaching point list up/down. Moves all points if multiple points were selected.
Get location	Acquires the robot posture that is the target of operation. A name is automatically attached at the time when acquired, is added prior to selected line when teaching point was selected and added to the end of the list when not selected. The name can be changed.
Delete location	Deletes the teaching point selected in the teaching point list.
Move to	Moves the robot to the teaching point selected in the teaching point list.
MOV/MVS	Select MOV or MVS as the method to move to the teaching point selected in the teaching point list.

<table>
<tr><th>Item</th><th colspan="2">Explanation</th></tr>
<tr><td rowspan="4">Select frame
</td><td colspan="2">Select the output coordinate system of the instruction point from either of an absolute coordinate in the robot coordinates or relative coordinates from the frame.
The frame of the object is selected when outputting it by relative coordinates.</td></tr>
<tr><td>Frame specification</td><td>No frame specification</td></tr>
<tr><td></td><td></td></tr>
<tr><td>プログラム出力例
1 '
2 Tool (0.0, 0.0, 96.0, 0.0, 0.0, 0.0)
3 PF=Fram(P01,PX1,PY1)
4 Base Inv(PF)
5 Mov P01
6 Base P_Nbase</td><td>プログラム出力例
1 '
2 Tool (0.0, 0.0, 96.0, 0.0, 0.0, 0.0)
3 Mov P01</td></tr>
<tr><td>Add to Flow
</td><td colspan="2">It is possible to add the teaching point selected in the teaching point list to the flow. Is added to selection line when operation is selected or added to last line if not selected. If multiple items were selected then all selected items are added.</td></tr>
</table>

10.2. Path Creation

A path refers to a series of movements of a robot, for instance to trace a specific area on a workpiece (edge area) with a processing hand. Paths created here can be reflected in the final robot program output by registering them in work flows.

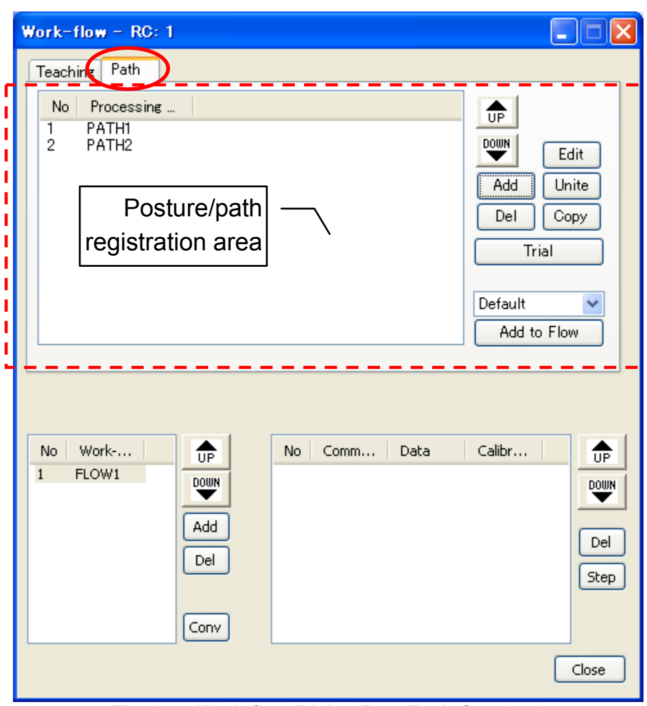


Fig. 10-3 Work-flow Dialog Box (Path Creation)

Operation procedure

① Click the [Add] button in the Path tab to add a path to the list.

② Double-click the created path or select it and then click the [Edit] button to open the Processing setting dialog box and edit the information in detail. This is explained in more detail in the next chapter.

③ Select unnecessary paths from the list and click the [Del] button.
④ Select a path and click the [Trial] button to check the robot movement.
⑤ Select a path and calibration and then click the [Add to Flow] button to add them to the work flow. The work flow must be created in advance (see “10.4 Work Flow Creation”).

Table 10-2 Details of Operations in the Dialog Box

Item	Explanation
Path list	Displays a list of created paths. Double-click an item in the list to display the Processing setting dialog box, in which it is possible to make detailed settings for the path.
UP/DOWN	Changes the order of the path list. Click these buttons to move the position of the path selected in the path list up/down.
Add	Adds a new path to the path list. A name is automatically attached at the time when added and is added prior to the selection line when the path is selected, or added to the last place on the list if not selected. The added name can be changed. Click this button to add a new path to the path list for which no settings have been made. Click the [Edit] button or double-click the item in the path list to make detailed settings for the path.
Del	Deletes a path. Click this button to delete the path selected in the path list.
Edit	Edits detailed settings of a path. Click this button to edit detailed settings of the path selected in the path list.
Unite	Unites multiple paths into a single path. Click this button to combine multiple paths selected in the path list to create a new path. Only information of edges and faces is combined for the created path. Other setting information such as the speed and tool offsets is used in the lead (beginning) path information. (Processing methods calibrated by tool offset are cancelled.)
Copy	Copies a path. Click this button to copy the path selected in the path list.
Trial	Tries out a created path. Click this button to check whether or not there are any impossible postures along each of the created paths. At this point, the Robot operation dialog box should be displayed, so that you may observe the angle of each axis and other information during movement.
Calibration selection	Click this button to select the calibration data to be used when correcting the path selected in the path list.
Add to Flow	Adds a path to a flow. Path is added prior to selection line when operation was selected or is added to the last line if not selected. Click this button to add the path selected in the path list to the flow. If multiple items were selected then all selected items are added.

10.3. Processing Setting Dialog Box

Information required for processing is set using this dialog box. The table below explains the information required for processing in details.

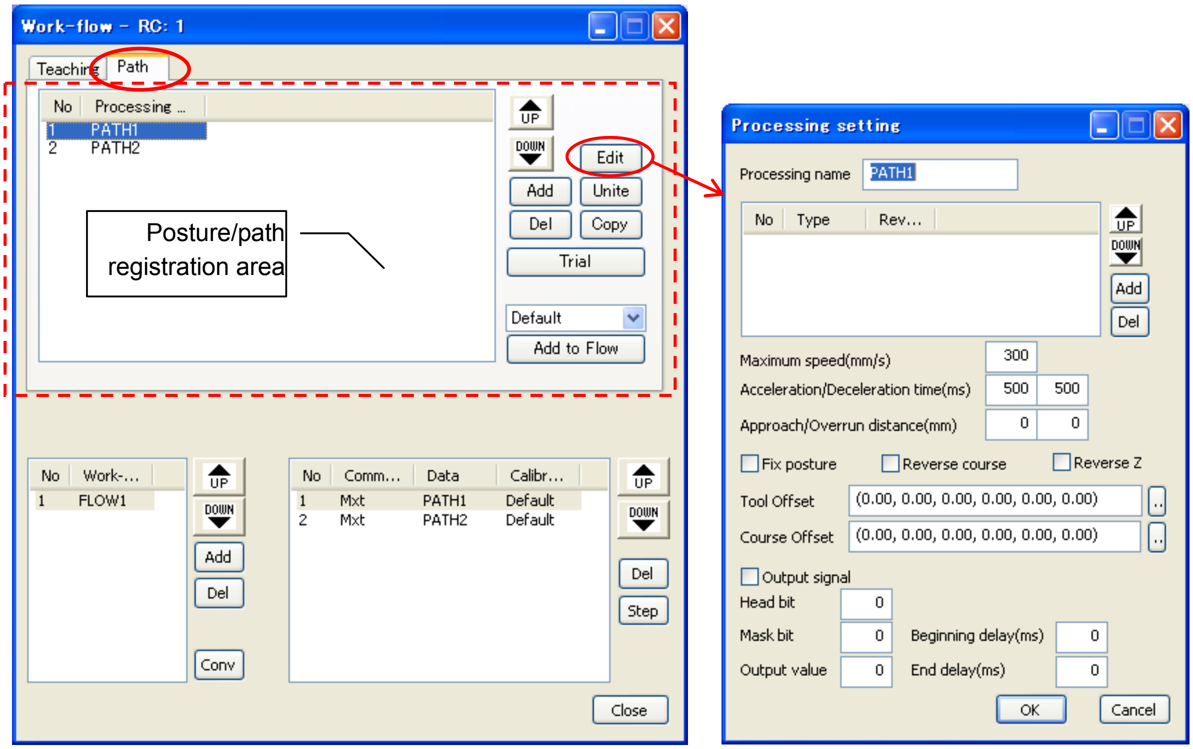


Fig. 10-4 Processing Setting Dialog Box

Operation procedure

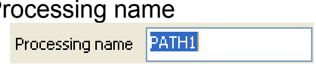
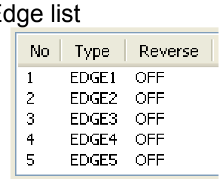
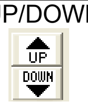
① Double-click the created path or select it and then click the [Edit] button in the Path tab to open the Processing setting dialog box and edit the detailed information. The details are explained in the next chapter.

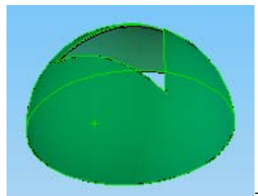
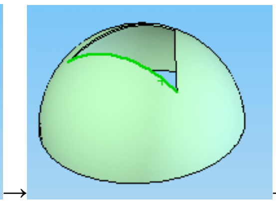
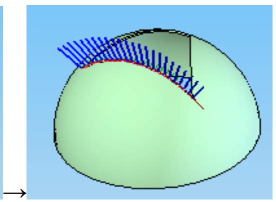
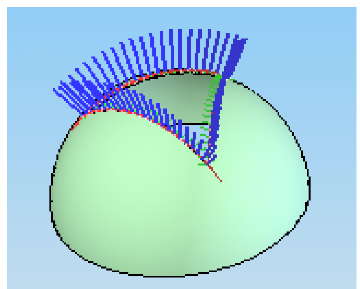
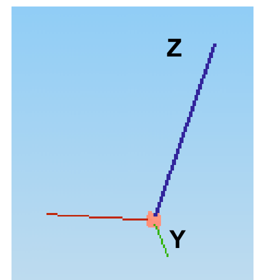
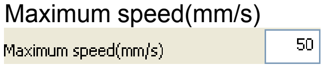
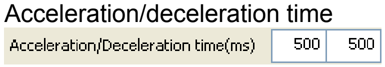
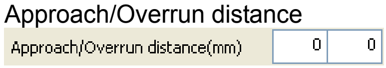
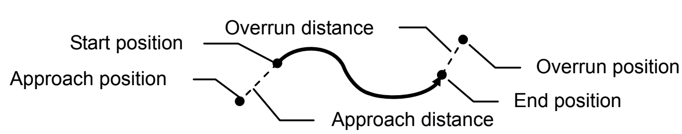
② Select unnecessary paths from the list and click the [Del] button.

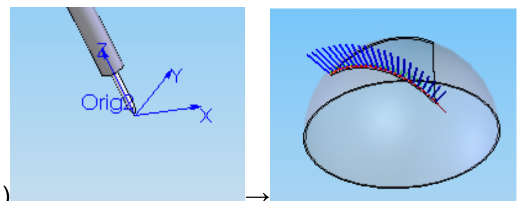
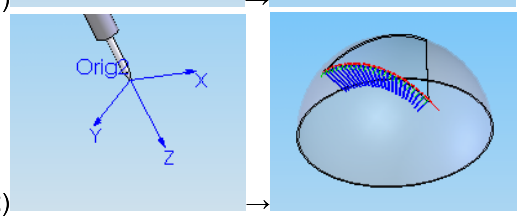
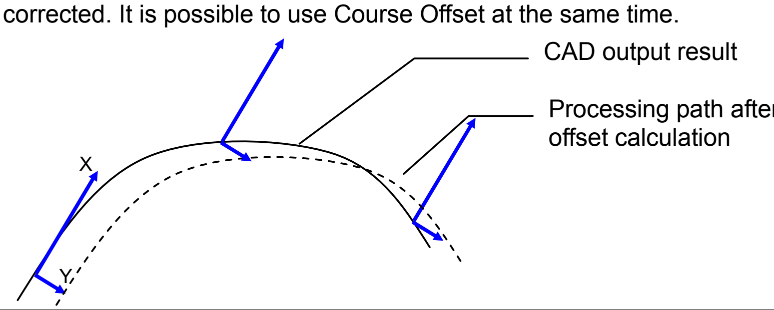
③ Select a path and click the [Trial] button to check robot movement.

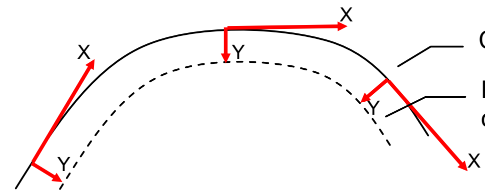
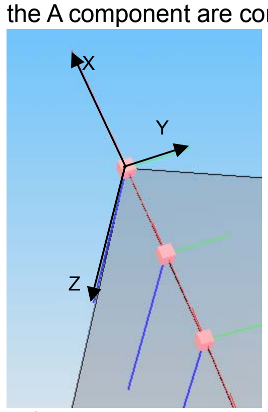
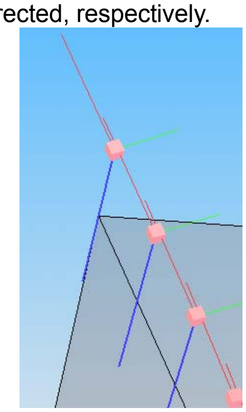
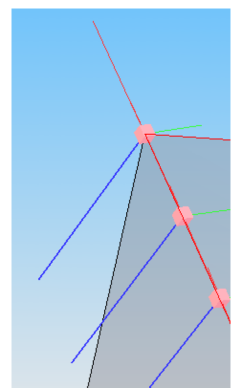
④ Select a path and calibration and then click the [Add to Flow] button to add them to the work flow.

Table 10-3 Details of Operations in the Dialog Box

Item	Explanation
Processing name 	Displays the name of the path selected in the Work-flow dialog box. When adding a new processing, the default name is set; the path name can be modified by changing the information in this text box.
Edge list 	Displays segments constituting the path selected in the Path creation dialog box as a list. When the registered edge is double-clicked, it reverses.
UP/DOWN 	Change the order of the segment list. Click these buttons to move the position of the segment selected in the segment list up/down.

<table>
<tr><th>Item</th><th>Explanation</th></tr>
<tr><td>Add
</td><td>Adds a new segment to the segment list. It is added to the selection line when the segment is selected or added to the last line if not selected.
Select a face on the window and click the [Add] button to add a new path. When a path is correctly added, a dot sequence is drawn as shown in the figure below. Since edges (segments) and faces (surfaces) of the workpiece clicked last are selected, click a face once and then click an edge related to the face and the [Add] button repeatedly, to add the edges quickly and efficiently.
* The object of the processing is only workpiece("***_Work.sldprt").
 →  → 
Click a face　Click an edge　Click [Add]

Repeat until done

Coordinate system</td></tr>
<tr><td>Del
</td><td>Deletes a segment.
Click this button to delete the segment selected in the segment list.</td></tr>
<tr><td>Maximum speed(mm/s)
</td><td>Specify the maximum speed of the robot when it processes a segment.
Specify the speed at which to trace an edge (mm/s).</td></tr>
<tr><td>Acceleration/deceleration time
</td><td>Specify the acceleration/deceleration time of the robot when it processes a segment.</td></tr>
<tr><td>Approach/Overrun distance
</td><td>Specify the approach and overrun distances of the robot when it processes a segment.
At the start and end of robot movement, the speed fluctuates due to acceleration/deceleration. In order to be able to process the specified edge at a constant speed, specify approach and overrun distances.
Approach: It is possible to set an approach position at a point along an extension of the specified edge, extending from the start position of the edge in the opposite direction of the traveling direction. Specify the distance of the approach section (mm).
Overrun: It is possible to set an overrun position at a point along an extension of the specified edge, extending from the end position of the edge in the traveling direction. Specify the distance of the overrun section (mm).

*Specification by 1/100mm unit is possible. 1/1000mm or less is rounded down.</td></tr>
</table>

Item	Explanation
Fix posture ☑ Fix posture	Specify whether or not the posture should be fixed when the robot processes a segment. If the check box is enabled, the posture is fixed. If it is disabled, the posture is not fixed.
Reverse course ☑ Reverse course	Specify whether or not to reverse segment processing direction. If the check box is enabled, the course is reversed. If it is disabled, the course is not reversed.
Reverse Z ☑ Reverse Z	Specify whether or not to reverse in the Z-axis direction of a dot sequence when the robot processes a segment. If the check box is enabled, the coordinate system is reversed in the Z-axis direction. If it is disabled, the coordinate system is not reversed. When a hand processing area traces an edge, it moves by matching the Z direction of Orig2 to the normal line direction and the X direction of Orig2 to the traveling direction. Thus, it is possible to determine absolutely whether or not to reverse in the Z-axis direction by the processing point ("Orig2") and the normal line direction on the face when creating a hand. (Example 1)  → (Example 2)  → *[The normal line direction] reverse for RH/RP series.
Tool Offset Tool Offset (0.00, 0.00, 0.00, 0.00, 0.00, 0.00) ...	Offsets a line in the tool coordinate system. Enter a value directly into the text box or enter the amount of offset in the offset input dialog box displayed by clicking the button next to the text box. Tool Offset specifies the amount of deviation when the actual hand processing point deviates from the processing point (coordinate system "Orig2") on the hand model. The figure below shows an example where the Y component is corrected. It is possible to use Course Offset at the same time. 

Item	Explanation
Course Offset Course Offset (0.00, 0.00, 0.00, 0.00, 0.00, 0.00) ..	Offsets the course of a line. Enter a value directly into the text box or enter the amount of offset in the offset input dialog box displayed by clicking the button next to the text box. Specify the amount of offset in the coordinate system where the forward direction of the segment course is set as the +X-axis direction and the direction away from a face as the +Z-axis direction. For example, when tracing a curve, the Y component indicates the inward/outward rotation, the Z component indicates the amount of approach and the A component indicates the bank angle. The figure below shows an example where the Y component is corrected.  The examples in the figures below show the standard conditions, conditions where the Z component is corrected, and conditions where the A component are corrected, respectively.  Standard condition Z component correction A component correction
Output signal ☑ Output signal	Sets the signal condition. If the check box is disabled: The signal status before processing is maintained as is. If the check box is enabled: Turns the signal on according to the set conditions and off at completion.
Head bit Head bit 0	When outputting signals while the robot is processing a segment, it is possible to specify the head bit of the output signal (decimal expression).
Mask bit Mask bit 0	Specify the bits to be controlled for 16 bits from the head bit (hexadecimal expression).
Output value Output value 0	Specify a value to be output (decimal expression). The actual output consists of the bits, starting from the head bit, for which the corresponding mask bits are turned on.
Beginning delay Beginning delay(ms) 0	Allows specifying to turn a signal on after the specified time (in milli seconds) has elapsed since the beginning of movement. A negative value can be set here as well. In this case, the robot starts moving after the specified number of seconds has elapsed after the signal is output.
End delay End delay(ms) 0	Allows specifying to turn a signal on after the specified time (in milli seconds) has elapsed since the end of movement. A negative value can be set here as well. In this case, the signal is turned off the specified number of seconds before the robot reaches the end point.

Each item set in this dialog box becomes valid for all edges displayed in the segment list.

10.4. Work Flow Creation

In the Work-flow creation dialog box, it is possible to create a work flow by combining already created teaching points and paths. A created work flow can be converted into a robot program used as a template for actual operational programs.

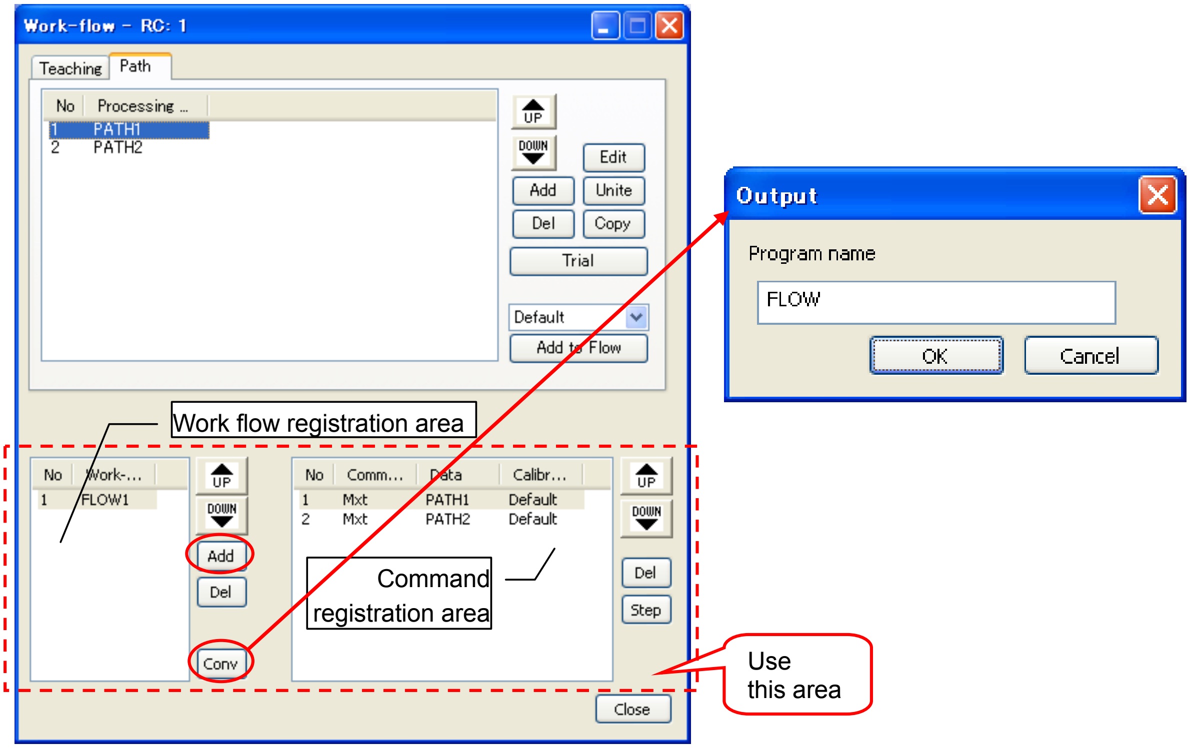


Fig. 10-5 Work-flow Dialog Box (Work Flow Creation)

Operation procedure

① Click the [Add] button to create a new work flow.

② Select the Teaching or Path tab to register teaching points and paths registered in each tab to the work flow.

③ Select the teaching tag or the path tab, click the “Add to Flow” button for each teaching point or path that was formed, and register it in the work flow.

④ Click the [Conv] button to create the following files from the work flow.

For example) when input “FLOW” to the Program name, the path of File becomes the following folders.

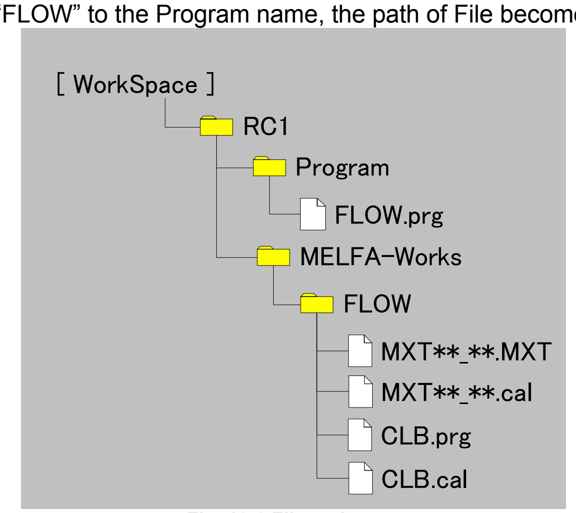


Fig. 10-6 File path

Table 10-4 List of Output Files

MXT***.mxt	Path data. A robot program loads this file to trace the specified processing area. The file name is automatically generated based on the number of dot sequences output and similar.
MXT***.cal	A copy of MXT***.mxt
CLB.prg	A calibration program. This program is transferred to a controller by the calibration tool. By performing teaching with the transferred program, correction values are calculated based on the teaching results.
CLB.cal	A copy of CLB.prg
FLOW.prg	A work flow converted into a robot program. A movement program is automatically generated from the relevant path data. This program can be used as it is, but the final program is typically created by adding instructions and similar to this program according to the environment employed by the customer.

Table 10-5 Details of Operations in the Dialog Box

Item	Explanation
Work flow list No Work-flow ... 1 FLOW1 2 FLOW2	Displays a list of created work flows. The items displayed are work flow No. and work flow name. Double-click an item in the list to display the name change dialog box, in which you can change work flow names.
UP/DOWN UP DOWN	Change the order of the work flow list. Click these buttons to move the position of the work flow selected in the work flow list up/down.
Add Add	Adds a work flow. Name is automatically added at the time when added, and is added prior to selection line when work flow was selected or added to end of the list if not selected.The added name can be changed. Click this button to create a new work flow.
Del Del	Deletes a work flow. Click this button to delete the work flow selected in the work flow list.
Conv Conv	Converts a work flow into a robot program. Click this button to convert the work flow selected in the work flow list and create a robot program and/or **a dot sequence data set** (information based on which an actual robot can move).

Table 10-6 Details of Operations in the Dialog Box

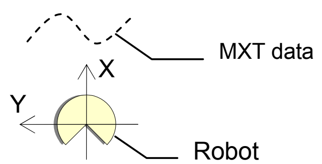
Item	Explanation
Teaching point/path list No Command Data Calibration 1 Mxt PATH1 Default 2 Mxt PATH2 Default	Displays teaching points and paths constituting a work flow as a list. The items displayed are item number, instruction name of item, teaching point/path name and calibration name of teaching point/path.
UP/DOWN UP DOWN	Change the order of the teaching point/path list. Click these buttons to move the position of the teaching point/path selected in the teaching point/path list up/down.
Del Del	Deletes a teaching point/path. Click this button to delete the teaching point/path selected in the teaching point/path list.
Step Step	It moves to the specified position for the move command. The MXT operation is executed at the MXT instruction. The cursor moves to the following line after completing the movement. However, it doesn't interpolate for moving command.

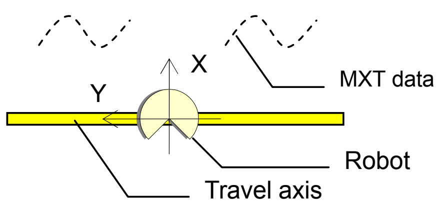
10.4.1 MXT with Travel base

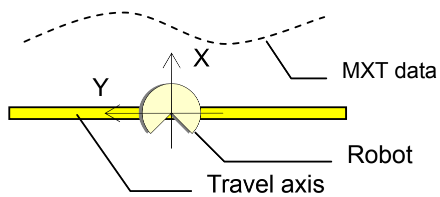
There is a limitation in the MXT operation of MXT with Travel base. CAD Link cannot operate though Travel base is operated.

Please avoid making Travel base effective and using MXT.

Table 10-7 Details of Operations in the Dialog Box

<table>
<tr><th>Item</th><th>Figure</th><th>Explanation</th></tr>
<tr><td>Case1</td><td>
</td><td>Type of fixed robot

MXT operates by the robot without Travel base.</td></tr>
<tr><td>Case2</td><td>
</td><td>Type of with Travel base1

The robot stops at the position of the Travel axis by the robot with Travel base and MXT operates.
The value of the Travel axis when the MXT data is made by [conv button] is output to the MXT data.</td></tr>
<tr><td>Case3</td><td>
</td><td>Type of with Travel base2

It synchronizes with Travel axis, and MXT operates in the area more than the motion limit of the robot.

Not Support.</td></tr>
</table>

Memo

About MXT Data (Path Data)

When you use the MXT data(*.mxt) output by [Conv] button. It is necessary to **<u>forward it to Robot Controller</u>** by Calibration tool.

Please refer to Chapter 17 for details.

11. Virtual Controller

MELFA-Works allows starting a virtual robot controller supporting a positioned robot. Since this virtual controller simulates the actual robot controller almost exactly, it can be used just like an actual controller in almost all operations, such as program creation, parameter setting and monitoring, using RT ToolBox2.
Also, by connecting a virtual controller with the currently displayed robot, the movement of a robot program can be reproduced as it is.

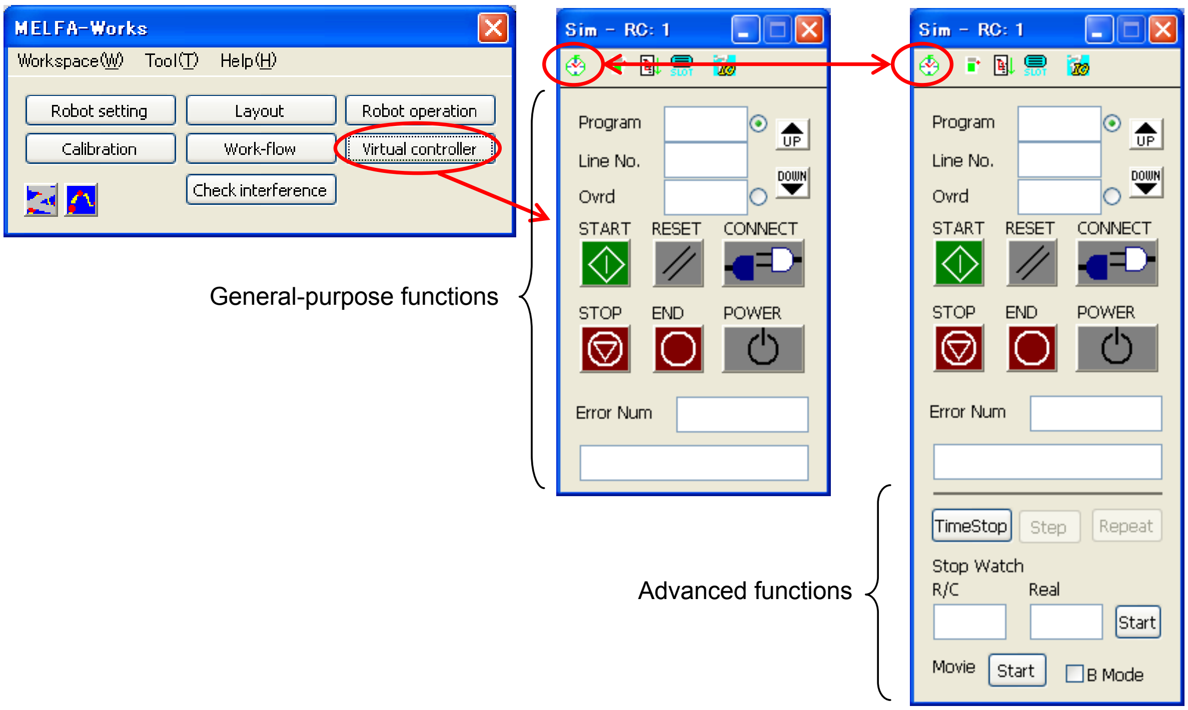


Fig. 11-1 Simulator Dialog Box

Click the [Virtual controller] button from the Main window to display the Simulator dialog box.
In this dialog box, buttons and other controls that are not used frequently are hidden as advanced functions.
Click the  button to expand the dialog box and display them as necessary.

CAUTION

When RT ToolBox2(before ver.1.2) starts

Communication server of RT ToolBox2(before Ver.1.2) cannot be used with MELFA-Works.
Please exit RT ToolBox2*(before Ver.1.2).

*RT ToolBox(before ver.G3a) is contained.

Table 11-1 Function Classification of the Simulator Dialog Box

Item	Explanation
General-purpose functions	Functions corresponding to those performed on the operating panel of a robot controller, such as program selection, start and end, are arranged in this section.
Advanced functions	The following functions, which are not part of the general-purpose functions, are arranged here. • Control of virtual controller time axis • Stopwatch that measures cycle times • Recording function • I/O ignore mode toggle switch (B Mode)

Table 11-2 General-purpose Functions

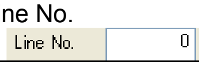
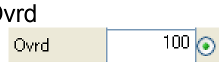
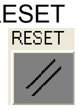
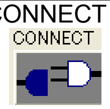
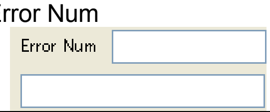
Item	Description
Program 	Displays the currently selected robot program name. After selecting [Program] with the option radio button, it is possible to select other programs using the [Up] and [Down] buttons.
Line No. 	Displays the line being executed in the currently executed robot program.
Ovrd 	Displays the current OVRD value. After selecting [Ovrd] with the option radio button, the value can be changed in increments of 10% using the [Up] and [Down] buttons.
START 	Executes the currently selected robot program.
RESET 	Resets an error or program. • When an error has occurred: The error is reset. • When a robot program is paused: The execution is returned to the first line of the program.
CONNECT 	Connects/disconnects the communication between the virtual controller and virtual robot. • When connected: The posture information is acquired from the virtual controller and the robot posture display is updated. • When disconnected: Updating of the robot posture is stopped to allow offline operation.
STOP 	Pauses the currently executed program. Press the [START] button to resume the program from the paused line.
END 	Ends the currently executed program in 1 cycle (the next time the END instruction is met). Press the [START] button to resume the program from the first line of the program.
Error Num 	Displays an error number. If an error occurs, the error number is displayed.

Table 11-3 Advanced Functions

Item	Description
Time Stop 	Stops using the virtual controller. Unlike normal stopping, the controller is stopped at the current position as if the time is frozen, even if the robot is operating at a high speed. Click the button again to cancel the time stop and return to the normal operation.
Step 	If the robot controller is stopped by clicking the [Time Stop] button, clicking this button allows the time to pass for a single time step (minimum controllable time unit). Also, an interference check is executed automatically after one step.
Repeat 	Executes [Step] repeatedly.

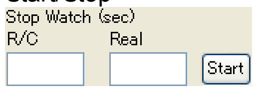
StopWatch(sec) Start/Stop  	Measures the time within the virtual controller as well as the actual time. It is possible to estimate an approximate cycle time. This function measures the time from clicking the [Start] button until it is clicked again. The measurement result is displayed in the [R/C] and [Real] boxes. * The time within the virtual robot controller can be measured only during executing a robot program.
Movie Start/Stop  	Saves robot movement and similar as moving images.
B Mode  	Select whether or not to operate a robot program in B mode. If the check box is enabled, a robot program is operated in B mode. B mode is a function that runs a robot program while ignoring signal inputs from external devices.

Table 11-4 Functions Assigned to Tool Tips

Item	Description
Cycle time measurement 	Displays the cycle time measurement section. The cycle time measurement section is displayed at the bottom of the Simulator dialog box.
JOG panel 	Displays the JOG Panel window. The JOG Panel window for operating a robot is displayed.
Step Execute/Direct Execute 	Displays the Step Execute/Direct Execute dialog box, in which it is possible to perform step execution/direction execution of a robot program.
Task Slot 	Displays the Task Slot dialog box, in which it is possible to check/correct task slots.
I/O Simulator 	Displays the I/O Simulator dialog box, in which it is possible to perform I/O simulation.

11.1. How to Execute Programs

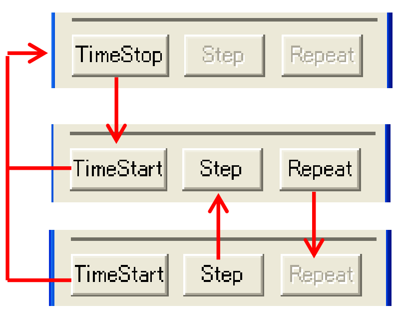
Execute a program using the following procedure.

① Click the [Virtual controller] button in the Main window to display the Simulation dialog box.
② Click the [POWER] button to launch the virtual controller.
③ Use RT ToolBox2 as necessary to change parameters of the virtual controller. If any parameters are changed, click the [POWER] button again to restart the virtual controller.
④ Use RT ToolBox2 to transfer the robot program to the virtual controller.
⑤ Click the [CONNECT] button to connect the virtual controller and the robot.
⑥ Click the [START] button to execute the program.

11.2. Checking Robot Interference

Carry out an interference check using the following procedure.

① Display the Check interference dialog box and set the targets of the interference check (see “Chapter 12 Interference Check).
② Execute a robot program and monitor the movement.
③ Click the [TimeStop] button before a critical operation to perform the interference check.
④ Click either the [Step] or [Repeat] button to start analysis (interference check).
⑤ When [Stop at interference] is enabled in the Check interference dialog box, the continuous analysis is stopped immediately if an interference is detected during continuous analysis.
⑥ To end the analysis, click the [TimeStart] button.



[TimeStop] button : Shift to analysis mode

[Step] button : Single step analysis
[Repeat] button : Executes continuous analysis.
[TimeStart] button : Cancels analysis mode.

[Step] button : Cancels continuous analysis.
[TimeStart] button : Cancels analysis mode.

Fig. 11-2 Switching among Analysis Modes

Tips

How to check efficiently

Since the calculation burden involved in an interference check is very heavy, the robot operation slows down. Checking only operations that are suspected of interference improves efficiency.

11.3. Saving Simulation Moving Images

It is possible to save the SolidWorks display area shown in the figure below as a moving image file.

* If another window is displayed on top of this area, the window is also saved as a part of the moving image.
* The processing may slow down depending on the window size. In such cases, you can scale down the window before using the function.

① When the operation you want to save starts, click the Movie [Start] button.
At this point, the button display changes to [Stop].
② When the operation you want to save is completed, click the Movie [Stop] button.
③ A dialog box for specifying the file to be saved appears; select a file name and save the file.

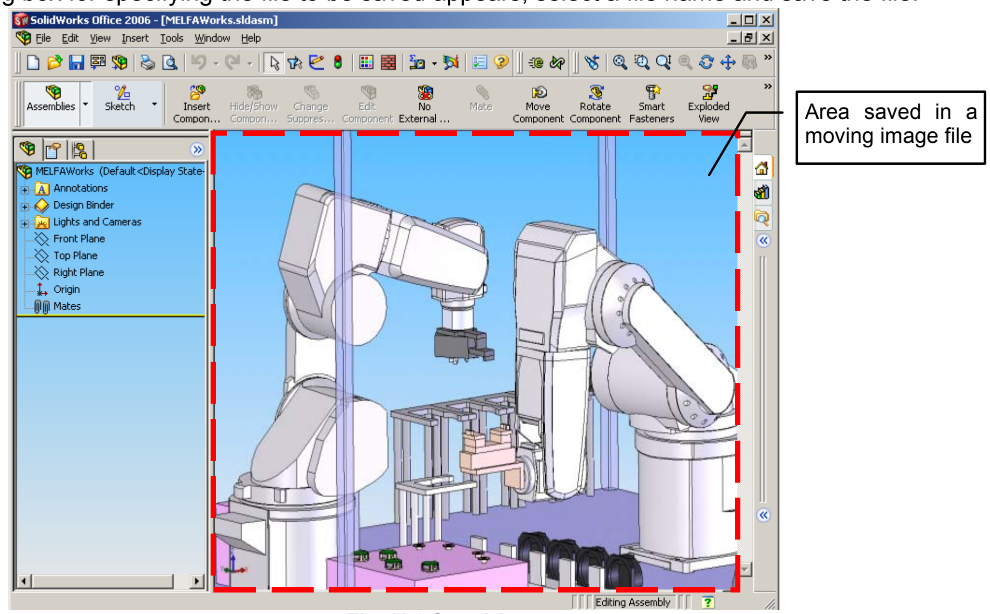


Fig. 11-3 Saved Area

* The processing may slow down depending on the window size. In such cases, you can scale down the window before using the function.

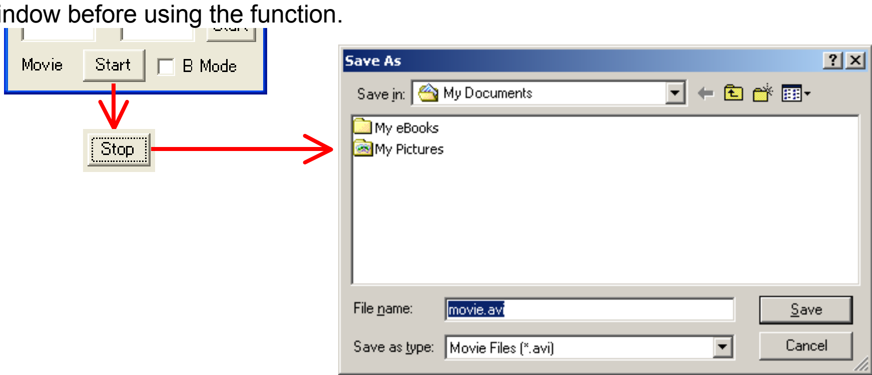


Fig. 11-4 Saving in Moving Image Files

11.4. Cycle Time Measurement During Program Execution

It is possible to measure cycle time just like using a stopwatch during execution of a program.

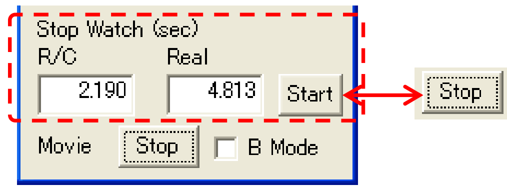
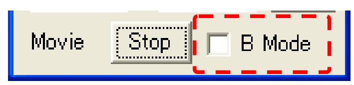


Fig. 11-5 Cycle Time Measurement

Start/Stop:	:	Start or end cycle time measurement of a specified robot. Click the [Start] button to start cycle time measurement. Click the [Stop] button to finish measurement and display the measurement result.
R/C:	:	Displays the robot operation time.
Real:	:	Displays the processing time on the personal computer.

11.5. B Mode Setting

A robot program can be operated by ignoring signal inputs from external devices (it is assumed that all signals are turned on).



Tips

What is B Mode?

B Mode is a function that runs a robot program while ignoring signal inputs from external devices (it is assumed that all devices are turned on). Not including stop signals.

12. Interference Check

MELFA-Works is able to check for interference among parts that are registered into 2 groups in a all combinations. In addition to simply checking the current interference status, it is also able to link with the continuous analysis mode of the virtual controller, such that a program can be stopped if interference is detected (refer to "11.2 Checking Robot Interference" for details).

Although the level varies depending on how powerful the personal computer executing the simulation is, the larger the number of registered parts, the longer the check time. Register the minimum required parts to use this function.

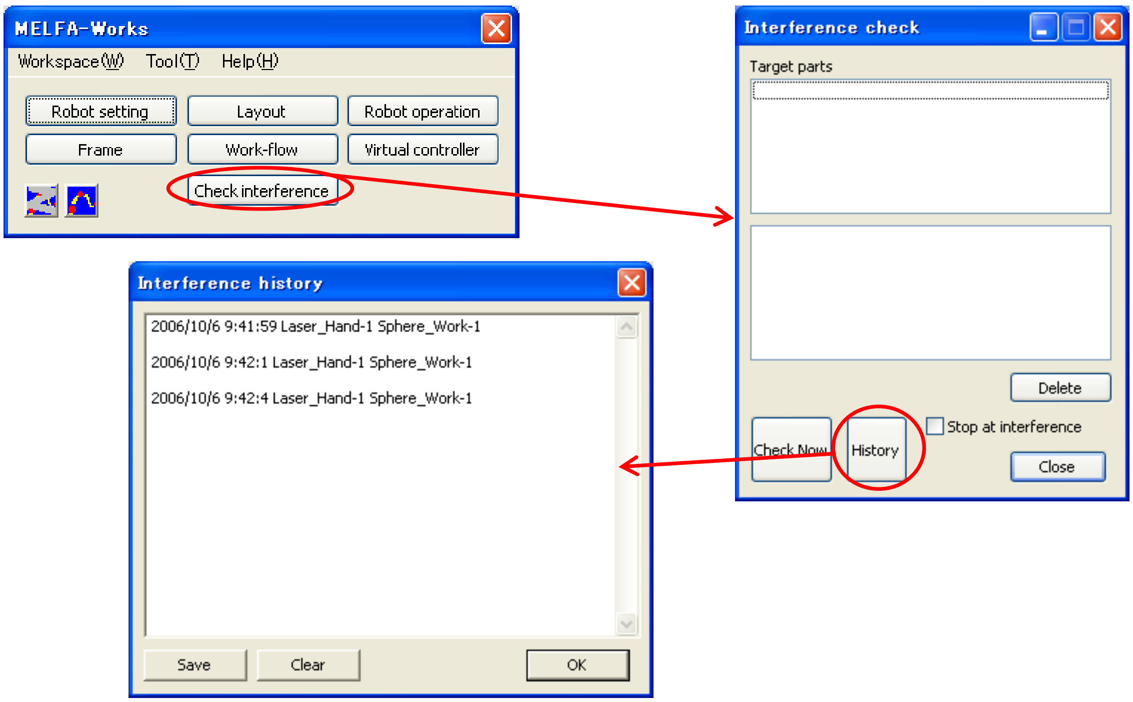


Fig. 12-1 Interference Check Dialog Box

Table 12-1 Details of Operations in the Dialog Box

Item	Explanation
Target parts list	While one of these lists is selected, click a part in SolidWorks to add the part name to the list. If the part has already been added to a list, it is deleted from the list. If parts on list are clicked, parts on corresponding SolidWorks become the selective states. In a round-robin system, interference is only checked between parts included in the upper and lower lists; interference is not checked within the same list. If interference is detected, the lists flash in red.
Check Now	Checks the current interference status. It is possible to check the interference status at the time of clicking the [Check Now] button.
History	Displays the Interference history dialog box. The Interference history dialog box shows a history of which part interfered with which part, along with the times when the interference occurred.
Stop at interference	If interference is detected, it is possible to stop the program immediately so that the user may check the interference status of the simulation. If this check box is enabled, the program is stopped when interference is detected. If the box is disabled, the program is not stopped.
Clear	Clears the interference history.
Save	Saves the interference history in a file.

13. Task Slots

Use the Task Slot dialog box to set multiple programs at the same time, for instance when using multitasking.

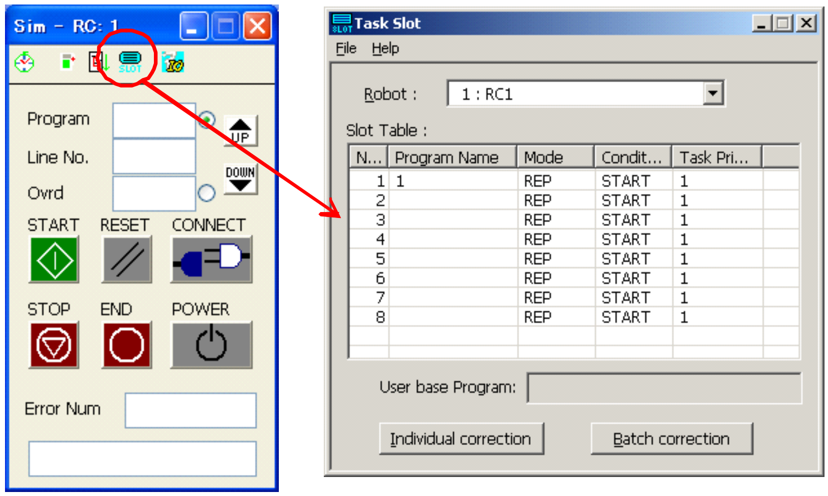


Fig. 13-1 Task Slots

There are the following 2 correction buttons.

[Individual correction]: : Make correction for the selected task slot.

[Batch correction]: : Make correction for task slots 1 to 8 and user base program settings at the same time.

13.1. Individual Correction of Task Slots

Make correction for the selected task slot.

Select a task slot for which you want to make correction from the list of task slots and click the [Individual correction] button (refer to Fig. 13-1 Task Slots).

Information of the selected slot is displayed. Specify the [Program file], [Mode], [Conditions] and [Priority], and then click the [Write] button.

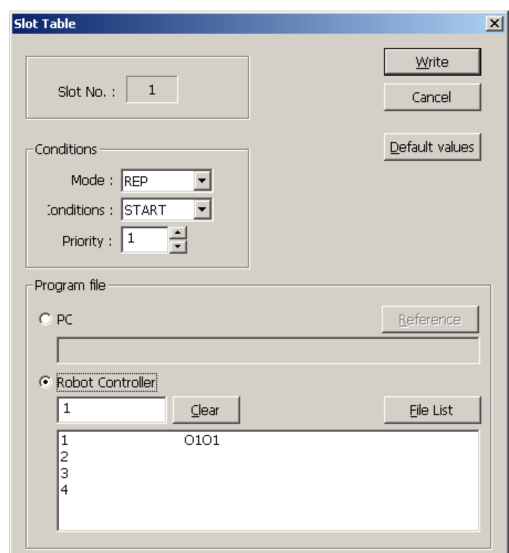


Fig. 13-2 Individual Correction

13.2. Batch Correction of Task Slots

Make correction of task slots 1 to 8 and user base program settings at the same time.
Select the connected robot in the combo box in the upper part of the dialog box and click the [Batch correction] button.

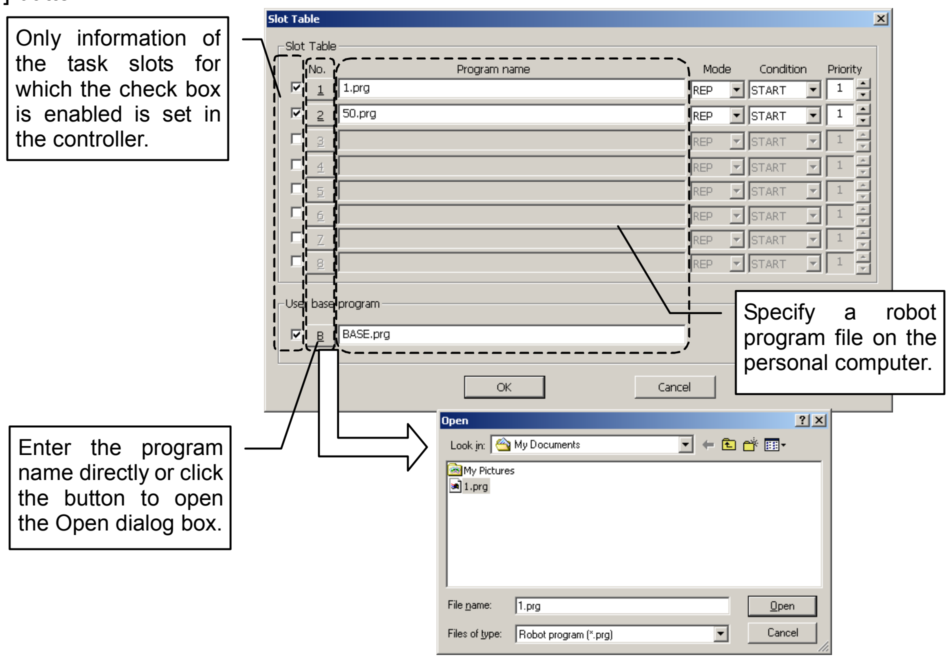


Fig. 13-3 Batch Correction

① Enable the check boxes of task slots to be corrected.
② Specify a program to be set to each task slot.
③ Modify the [Mode], [Condition] and [Priority] as required.
④ Click the [OK] button. When setting is completed, the corresponding virtual robot controller is restarted.

14. Input/Output Signal Simulation

The I/O simulator allows monitoring a robot's input/output signals and simulating these signals.

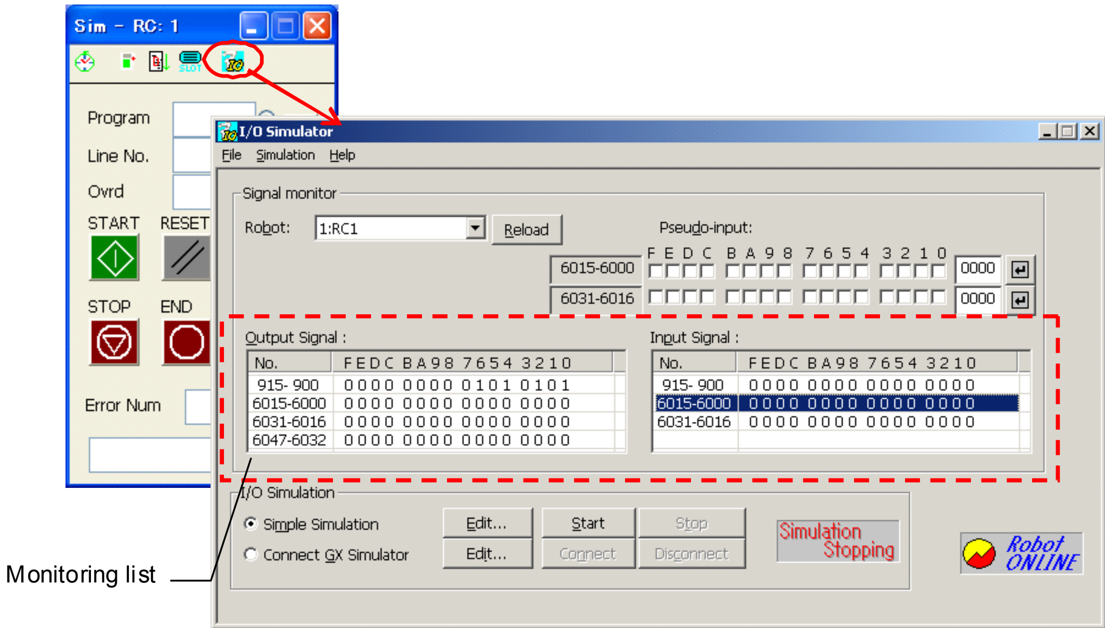
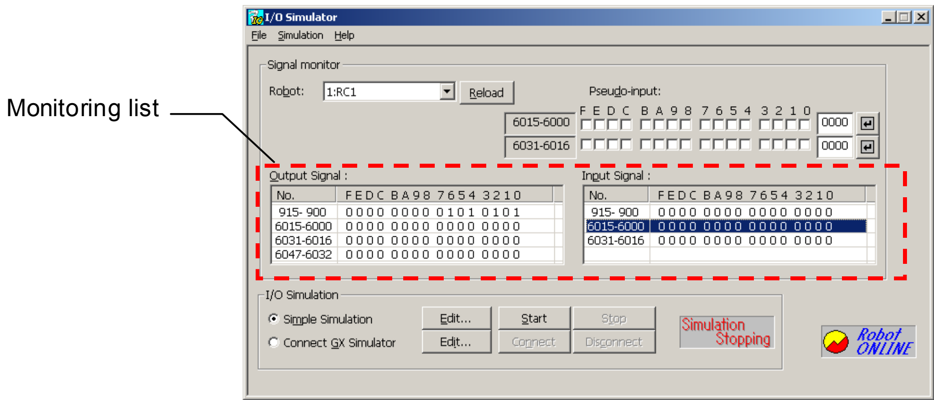


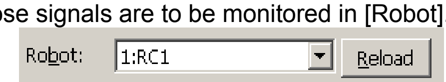
Fig. 14-1 I/O Simulator

14.1. Signal Monitoring



Select a robot controller to be monitored in [Robot] of the I/O Simulator window to display the current signal status in the monitoring list. Signals to be monitored are changed and added with the following procedure.

① Select a robot controller whose signals are to be monitored in [Robot].



② Double-click the monitoring list to display the Add/Change of the signal No. dialog box.

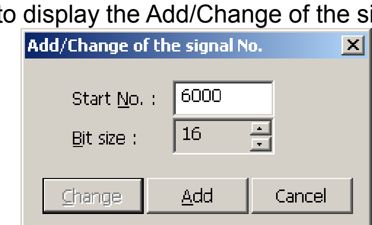


Fig. 14-2 Add/Change of the signal No.

③ Set the [Start No.] and [Bit size] to be displayed (the first row of the list (900 to 915) is fixed for hand signals; settings can be changed from the second row).

Click the [Change] button to change the information of the row currently selected in the monitoring list. If you set the bit size to 32 or more, bits in excess of 16 are inserted below the selected row.
Click the [Add] button to add the signals at the bottom of the monitoring list.

To delete signals from the monitoring list, select a target row from the monitoring list and click the [Delete] key.
It is also possible to select multiple rows and delete them at once.

14.2. Manual Signal Inputs

Input signals to a robot controller can be turned on/off.
Input signals are specified manually according to the following procedure.

Inputting 1 bit at a time

① Click a row in the controller's input signal list (the signal numbers of the selected row and the next row are displayed in the pseudo-input area).

② Enable/disable a check box to turn the corresponding controller input signal on/off (the status is updated immediately after the click).

Inputting 16 bits at once

③ Enter the hexadecimal value corresponding to the desired signal status in the input column and click the button.

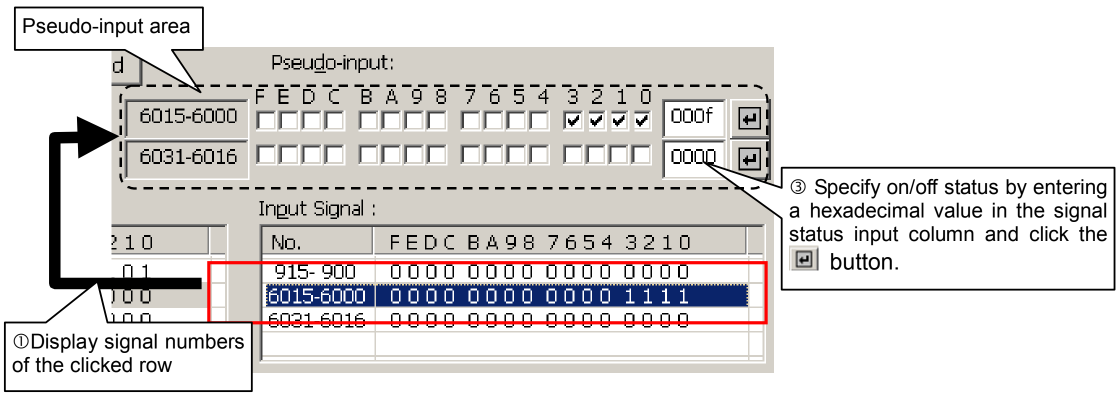


Fig. 14-3 Pseudo-input of Input Signals

14.3. Simulation Definition Settings

It is possible to simulate input/output signals. Define signals according to the following procedure in order to perform simulation.

① Click the [Edit] button in the [Simple Simulation] area of the I/O Simulator window to set the definition. The definition of I/O simulation window appears.

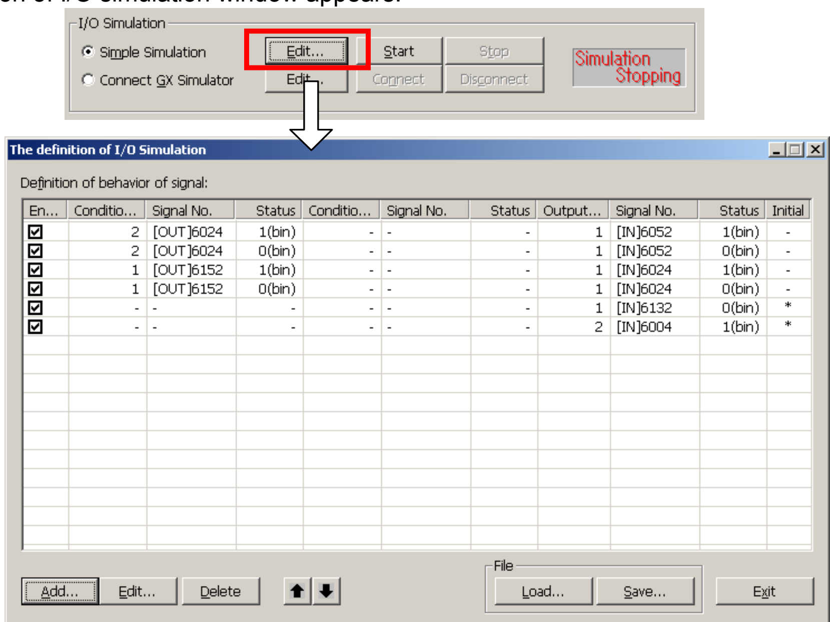


Fig. 14-4 Definition of I/O Simulation

② Add a signal operation definition.
Click the [Add] button at the bottom of the window to display the Setting of the behavior of the signal dialog box. Set the simulation conditions and signals output when the conditions are met in this dialog box.

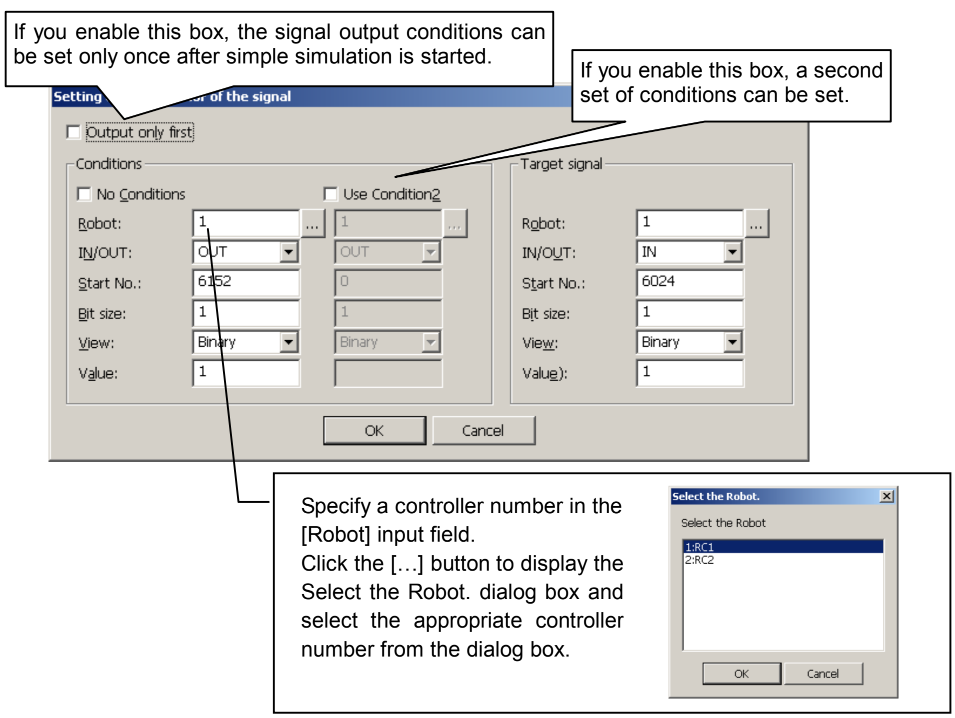


Fig. 14-5 Setting of the Behavior of the Signal

To change an already set definition, select it in the list and click the [Edit] button.
Alternatively, double-click it in the list to achieve the same effect.

③ The signal definition is added to the list.

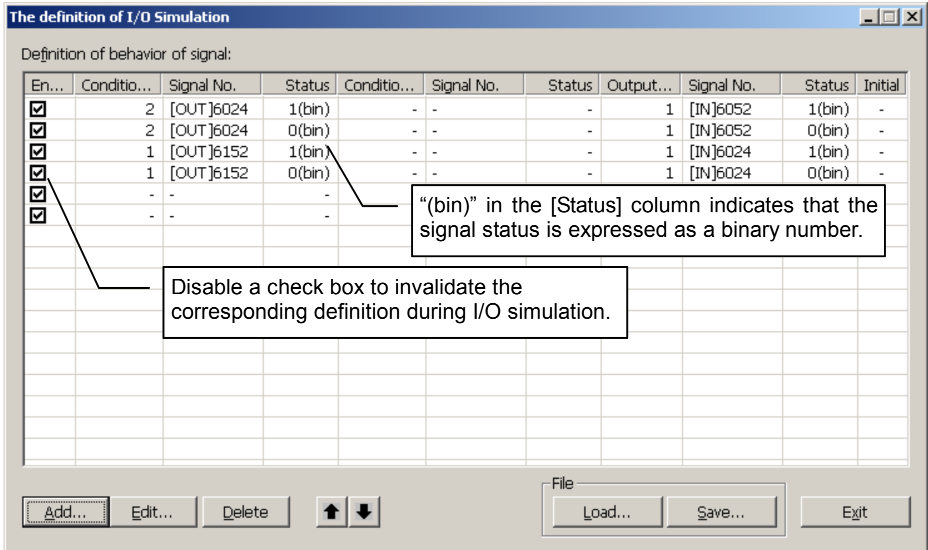
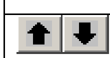


Fig. 14-6 Defined Simulation Conditions

It is judged whether the set definitions are met or not in order from the top of the list.
However, the initial execution definition is only output once when simple simulation is started (before normal simulation).

Table 14-1 Details of Operations in the Dialog Box

Item	Explanation
Add	Adds a simulation definition. Select a row and click the [Add] button to use the setting values of the selected row as the default values for the new definition.
Edit	Changes a simulation definition. Select a row and click the [Edit] button.
Delete	Deletes the definition of the selected row. It is also allowed to select multiple rows to delete them at once.
	Move the definition of the selected row up or down. It is also allowed to select multiple rows to move them at once.
Load	Loads simulation definitions from MELFA-Works project files. Please be careful when performing this operation; current definitions displayed in the list will be cleared.
Save	Saves the current simulation definitions in project files of MELFA-Works.

⚠ CAUTION

Be sure to stop the simulation before changing definitions.

During simulation, it is possible to check definitions, but it is not possible to add, change, delete or load definitions. Stop the simulation before performing these operations.

14.4. Executing Signal Simulation

To perform signal simulation, select the [Simple Simulation] option field button and click the [Start] button. Simulation is executed using the set definitions.

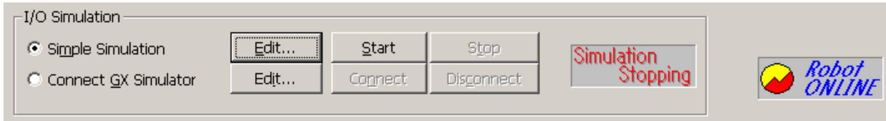
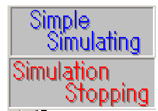


Fig. 14-7 Buttons Related to I/O Simulation

Simulation status is displayed.

Display while simulation execution:

Display when simulation is stopped:



If the [Start] button is clicked when no definition is set, a dialog box for selecting a definition setting method appears. Select a setting method and click [OK]. Definitions are loaded using the selected method and simulation is started.

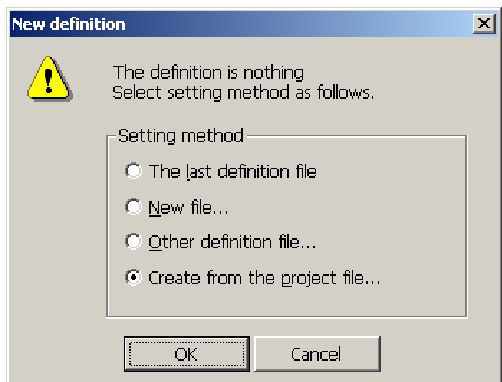


Fig. 14-8 New Definition Dialog Box

Tips

Starting simple simulation

Simple simulation is started when monitoring with MELFA-Works is started while I/O simulator is displayed as well.

14.5. Settings of Connection with GX Simulator

It is possible to connect with GX Simulator to simulate signal exchanges between the virtual controller in MELFA-Works and a PLC (represented by GX Simulator).

⚠ **CAUTION**

GX Simulator versions

Currently, MELFA-Works support GX Simulator Version 7 only.

To connect with GX Simulator, define GX Simulator devices and assign the signal numbers of the robot controller according to the following procedure.

① Click the [Edit] button after enabling the [Connect GX Simulator] radio button to set definitions. The Communication Setting with GX Simulator window appears.

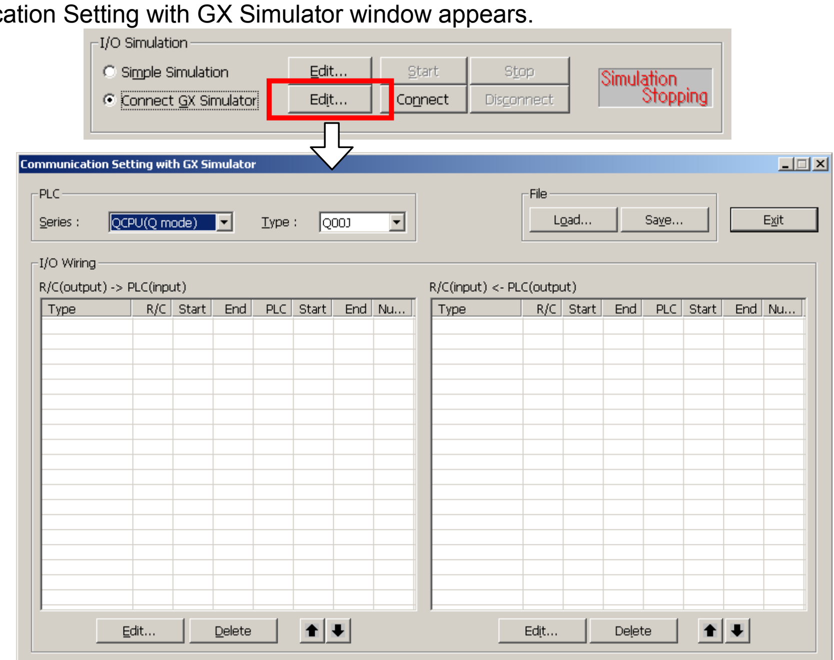


Fig. 14-9 Communication Setting with GX Simulator Window

② Select the [Series] and [Type] of a device set in GX Simulator.

③ Add an I/O wiring definition with GX Simulator.
Click the [Edit] button at the bottom of the definition list on the side to be defined to display the setting dialog box.
To change an already set definition, select it in either of the lists and click the [Edit] button.
Alternatively, double-click it in the list to achieve the same effect.

④ Set the signal numbers of the robot controller and the PLC device.
Select the signal types and the PLC device as well.

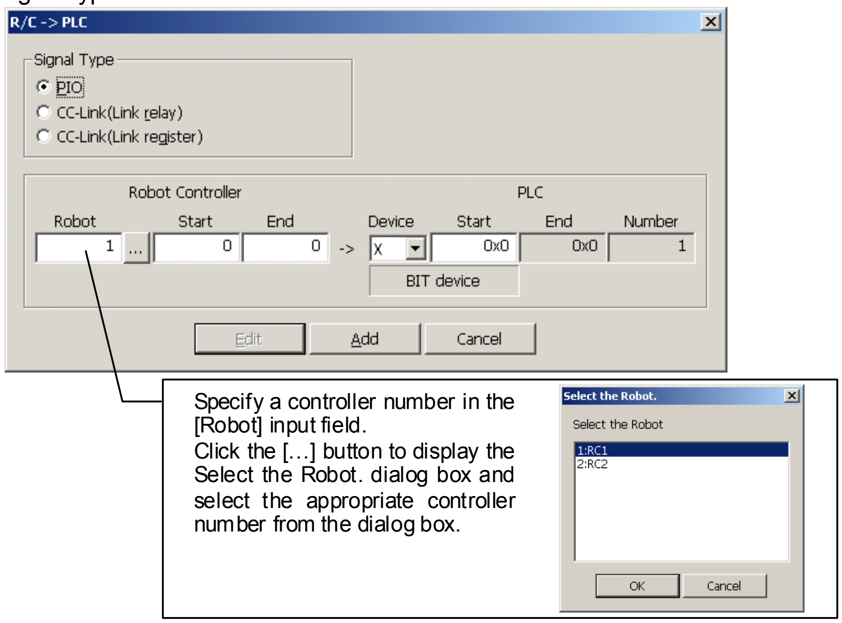


Fig. 14-10 Signal Connection Settings

Defined signals are added to the list as shown in the figure below.

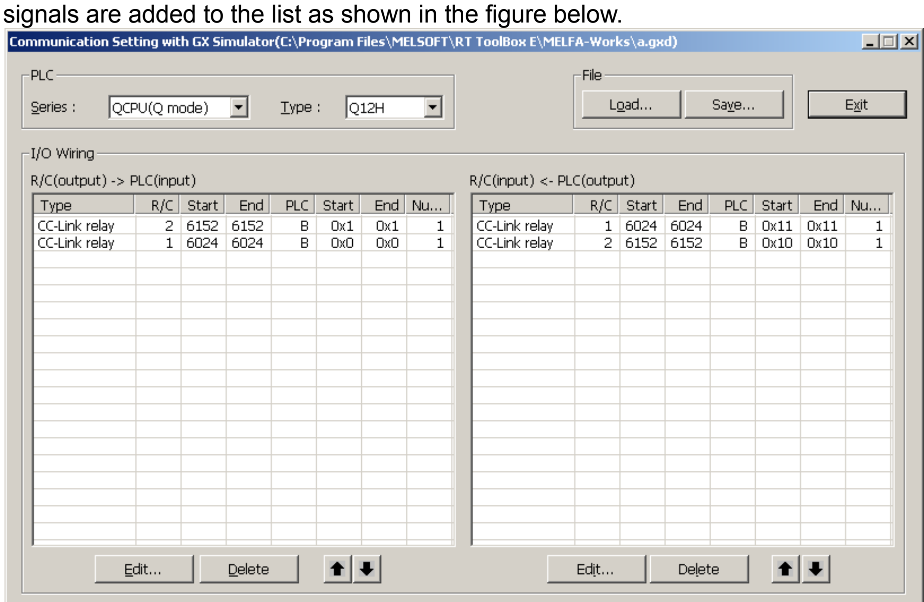


Fig. 14-11 Connection of Defined Signals

Table 14-2 Details of Operations in the Dialog Box

Item	Explanation
Edit	Edits a definition of connection with GX Simulator.
Delete	Deletes the definition in the selected row. It is also allowed to select multiple rows to delete them at once.
↑ ↓	Move the definition of the selected row up or down. It is also allowed to select multiple rows to move them at once.
Load	Loads definitions of connection with GX Simulator from MELFA-Works project files. Please be careful when performing this operation; current definitions displayed in the list will be cleared.
Save	Save the current definitions of connection with GX Simulator in project files of MELFA-Works.

14.6. Connecting with GX Simulator

To connect with GX Simulator, select the [Connect GX Simulator] radio button and click the [Connect] button. Connection is established with the set definitions.

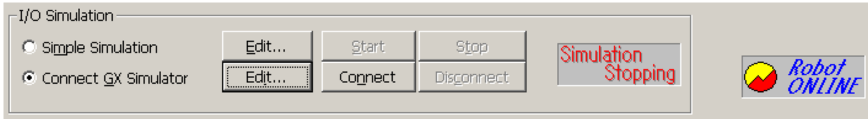


Fig. 14-12 Connect GX Simulator

Simulation status is displayed.

Display while connected with GX Simulator:

Display when simulation is stopped:

If the [Connect] button is clicked when no definition is set, a dialog box for selecting a definition setting method appears. Select a setting method and click [OK]. Definitions are loaded using the selected method and connection is established.

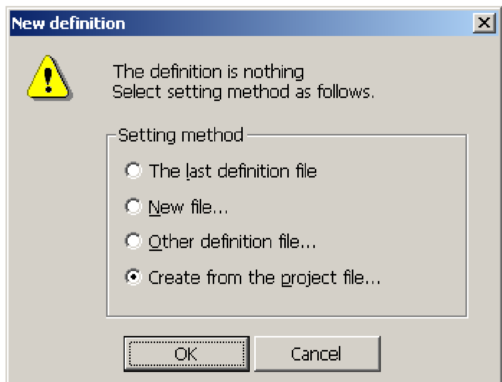


Fig. 14-13 New definition Dialog Box

⚠ CAUTION

Precautions when connecting to GX Simulator

When receiving GX Simulator pulse outputs with a robot controller or receiving pulse outputs from the robot controller with GX Simulator, be sure to have a pulse output time of 300 ms or more as a guideline.
This guideline varies depending on the performance and usage conditions of your personal computer as well. If GX Simulator and virtual controller operation were judged abnormal because their pulses could not be detected then try measures such as extending the pulse output time.

15. Step Execute/Direct Execute Dialog Box

15.1. Step Execution

It is possible to perform step execution of a specified program. Select the program to be started in the Simulator dialog box and open the Step Execute/Direct Execute dialog box from the toolbar. Next, click the [Reference (B)] button and select the program currently being executed from the robot program files on the personal computer; the preparation is now completed.

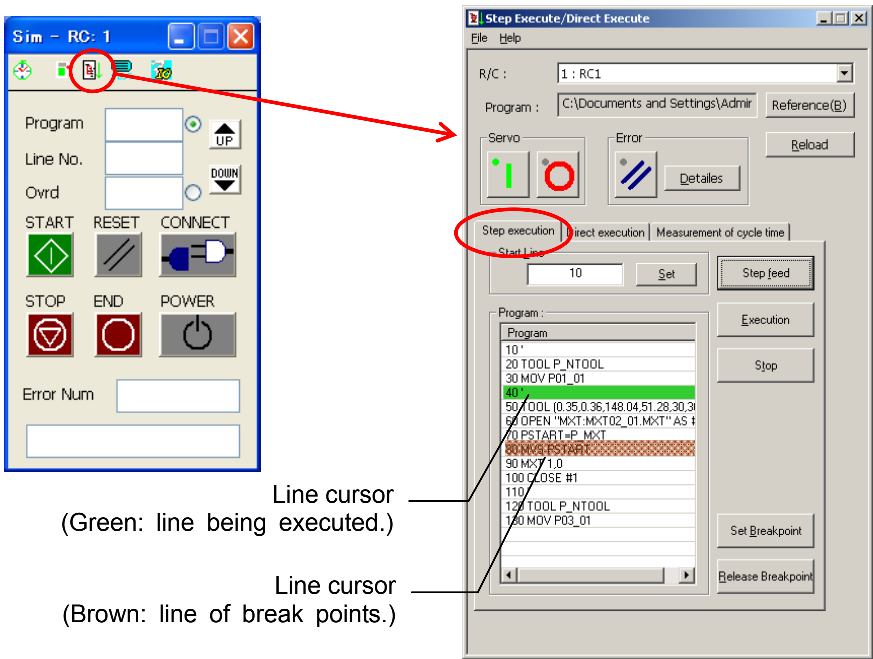


Fig. 15-1 Step Execution

Click the [Reference (B)] button to select a program on the personal computer.
The contents of the program are displayed in the Step execution tab.

Table 15-1 Details of Operations in the Dialog Box

Item	Explanation
Step feed	Executes a specified program step by step.
Execution	Runs a robot program from the current line continuously until it encounters a break point. If no break point is set, the program is run until END.
Stop	Stops the program being executed. The program is stopped immediately, even during the execution of a moving command.
Set Breakpoint	Sets points where a program is stopped. When the [Execution] button is clicked, the robot program stops at a line where a break point is set. Up to 8 break points can be set at the same time.
Release Breakpoint	Cancels break points already set.

15.2. Direct Execution

It is possible to execute MELFA-BASIC commands directly using instructions and position data specified for the program in question. Select a program to be started in the Simulator dialog box and open the Step Execute/Direct Execute dialog box from the toolbar. Next, click the Direct execution tab.

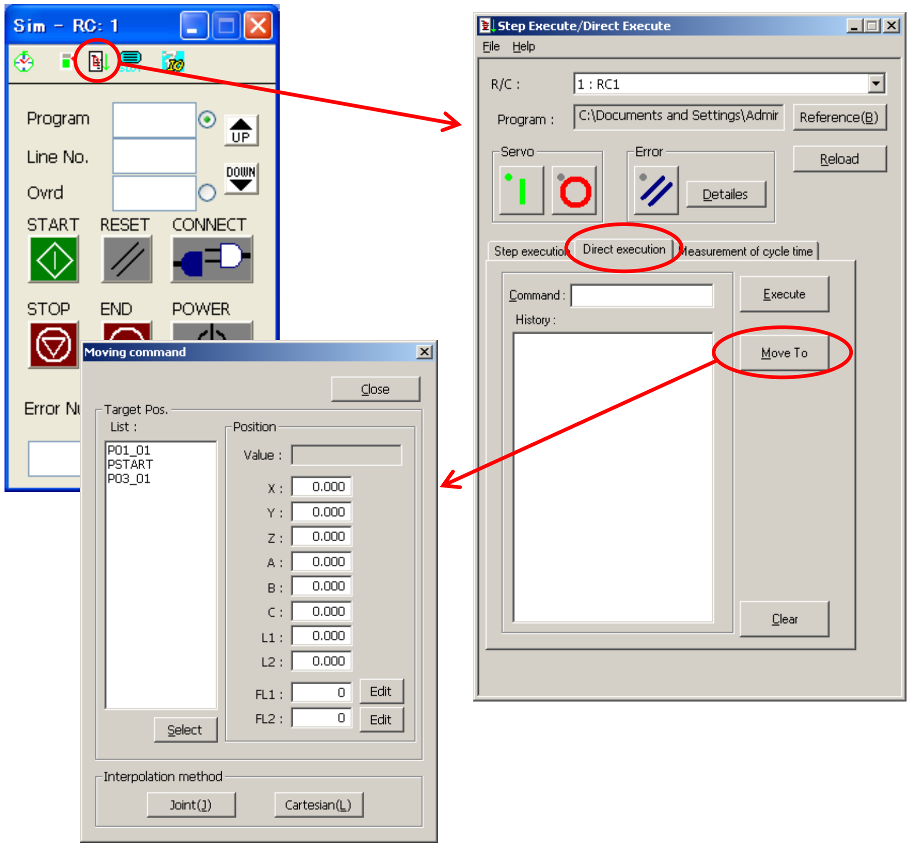


Fig. 15-2 Direct Execution

Table 15-2 Details of Operations in the Dialog Box

Item	Explanation
[Reference (B)] button	Select a program on the personal computer.
[Reload] button	Click this button after editing a program file to reload the program with the same file name as the currently loaded program.
[Command] field	Enter instructions to be executed directly.
[Execute] button	Execute an instruction entered in the [Command] input field. Executed instructions are added to the history list.
[History] list	Displays the history of directly executed instructions. Select an instruction from the [History] list and click the [Execute] button to execute the instruction.
[Clear] button	Clears the history of directly executed instructions.

[Move To] button	Executes robot move instructions using position data in the specified program. When you click the [Move To] button, the Moving command dialog box appears.
[Target Pos.] list	Double-click a position variable name among the program position data displayed in the list or select it and click the [Select] button to display the current value in the [Position] section. Click it to move the robot with the specified movement.
[Joint (J)] interpolation button [Cartesian (L)] interpolation button	Click these buttons to move the robot to the posture displayed in the [Position] section using the specified movement. It is also possible to change the value of each element in the [Position] section to move the robot.

⚠ **CAUTION**

Be sure to specify a program when performing direct execution.

A robot program must be specified when performing direct execution.

15.3. Measurement of Cycle Time

It is possible to measure the cycle time of a particular line of a specified program (MELFA-BASIC IV / MELFA-BASIC V). After selecting a program to be started in the Simulator dialog box, open the Step Execute/Direct Execute dialog box from the toolbar. Then click the Measurement of cycle time tab.

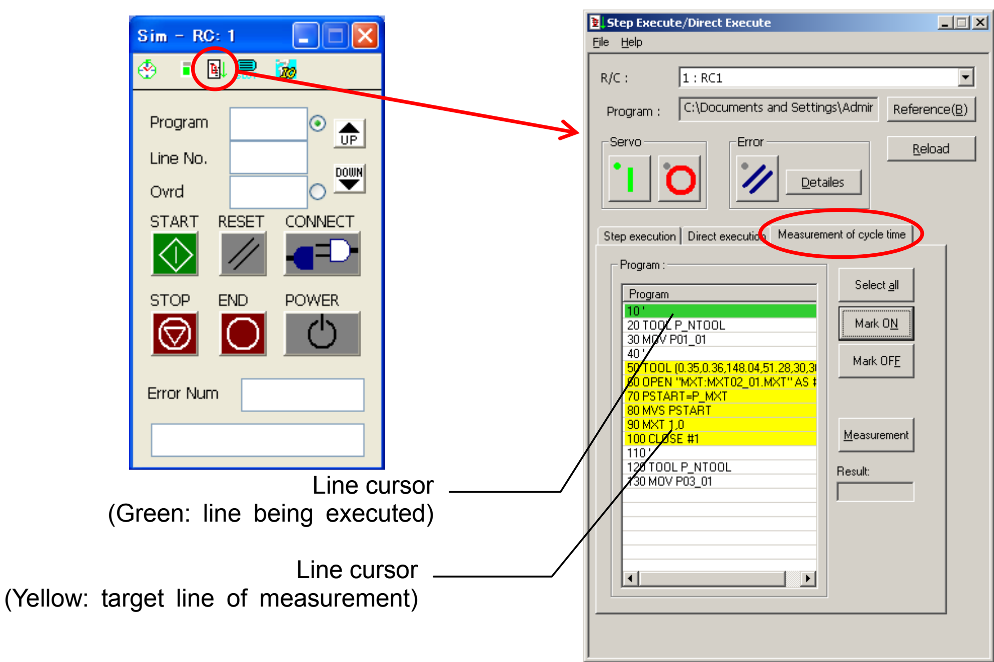


Fig. 15-3 Measurement of Cycle Time

Click the [Reference (B)] button and select a program on the personal computer.
The contents of the program are displayed in the Measurement of cycle time tab.

Table 15-3 Details of Operations in the Dialog Box

Select all	Specify all lines of a program to be measured (all lines are displayed in yellow).
Mark ON	Specify that the cycle time of the currently selected instruction lines should be measured. Select the start and end positions of measurement and click the [Mark ON] button; the lines in between are set as lines to be measured (displayed in yellow). Alternatively, click the start and end positions with the mouse while keeping the [Shift] key on the keyboard pressed to select the lines and then click the [Mark ON] button; the selected lines are marked.
Mark OFF	Cancel measurement line settings. Specified marks (yellow) are turned off.
Measurement	Execute instructions with Mark ON and measure their cycle time. The measurement results are displayed in the [Result] field.

CAUTION

About the calculation of the cycle time

MELFA-Works can treat eight robots in the specification. However, the performance changes greatly by the performance and the state of the load of the personal computer that uses it.
Please use it with one so that the decrease in the performance may influence the calculation of the cycle time when you calculate the cycle time.

Moreover, the calculated cycle time is not completely corresponding to the cycle time of a real robot. Please use the result as a reference value.

16. JOG Panel

When a robot displayed in SolidWorks is connected to a virtual controller, it is possible to perform jog operation using the JOG Panel window. Open the JOG Panel window from the toolbar of the Simulator dialog box.

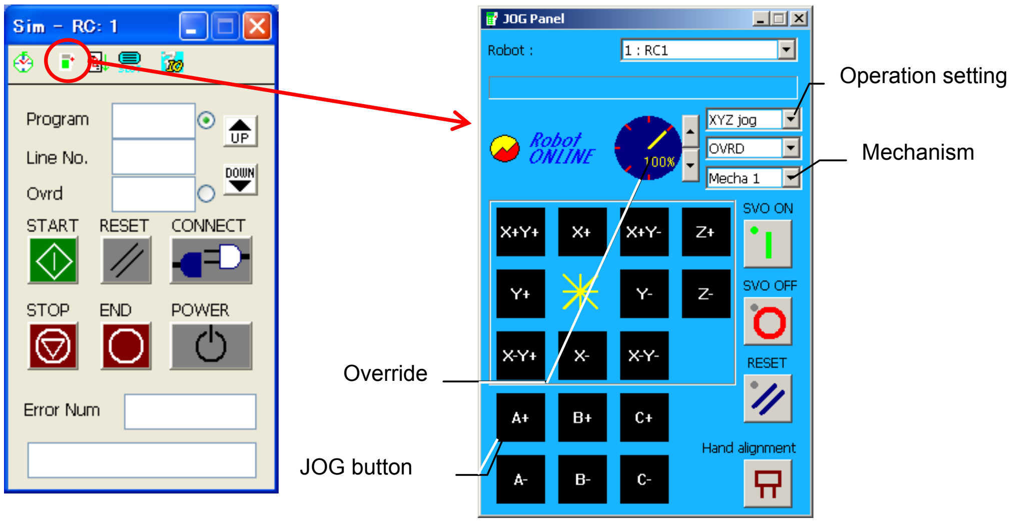


Fig. 16-1 JOG Panel

⚠ CAUTION

JOG operation cannot be performed during program execution.

In the same way as for actual robots, JOG operation cannot be performed during program execution.
However, the servo can be turned off.

Table 16-1 Details of Operations in the Dialog Box

[Robot] field	Select the target robot controller.
Override area	Change the speed override setting to the specified value. Specify the value using the button.
Operation setting field	Select JOG operation.
Mechanism field	Select the target mechanism from mechanisms connected to the controller.
JOG buttons	Click the button to start JOG operation. The display (XYZ/joint) changes depending on the operation setting.
[SVO ON] button	Turns the servo on. This button corresponds to the [SVO ON] button of the controller's operating panel.
[SVO OFF] button	Turns the servo off. This button corresponds to the [SVO OFF] button of the controller's operating panel.
[RESET] button	Reset errors and programs. This button corresponds to the [RESET] button of the controller's operating panel.
[Hand alignment] button	Aligns hands. *The hand alignment function moves the A, B and C components of the current position to the closest values in 90-degree unit.

17. How to Use the Calibration Tool

Calibration refers to correcting deviations between the system configured in the CAD software and the actual system. These tasks are performed using the calibration tool, which is not included in RT ToolBox2. Only when both RT ToolBox2 and MELFA-Works are installed, the calibration tool can be used.
The flow of tasks involved in calibration is as follows. Only point data is corrected by the calibration.

Specify an MXT file (*.MXT) output from MELFA-Works and load the corresponding dot sequence data.

↓

Transfer a calibration program for positional calibration to the robot controller.

↓

Teach the position variables of the calibration program to the robot.

↓

Load the calibration program into the tool.

↓

Correct the positions of the dot sequence data based on the loaded calibration program.

Positional calibration

↓

Transfer a program for distortion calibration to the robot controller.

↓

Teach the robot such that it is moved to the correct position in accordance with the dot sequence.

↓

Load the program for distortion calibration to the tool.

↓

Calibrate the distortion of the dot sequence data based on the loaded program for distortion calibration.

Distortion calibration

↓

Transfer the calibrated dot sequence data to the robot controller.

↓

Create a program that uses the dot sequence data on the robot.

The calibration methods can largely be divided into “positional calibration” and “distortion calibration,” and they have the following features.

Item	Explanation
Positional calibration	Calibrate the layout of the entire dot sequence data set. With this method, it is possible to correct deviations due to system assembly errors such as deviations between specified and actual robot and work station positions. Based on position deviations between 3 points specified in the CAD software and the corresponding actual points, the parallel and rotational component deviation in each coordinate system is calculated, and the entire dot sequence is calibrated accordingly.
Distortion calibration	Calibrate the specified part of the dot sequence data set. With this method, it is possible to correct deviations due to distortion of the workpiece itself and hand mounting errors. Specify the start and end of a part of the dot sequence data set for which position deviations should be calculated. Then teach several deviating points to the robot in order to correct the points in the specified sequence.

17.1. Starting the RT ToolBox2

The Calibration Tool is one of the functions of the RT ToolBox2.
The RT ToolBox2 startup icon appears on the desktop when the RT ToolBox2 is correctly installed.
[MELSOFT Application] – [RT ToolBox2] appears in the [start] menu, too.

Start the RT ToolBox2 tool from the [Start] menu or the icon on the desktop.

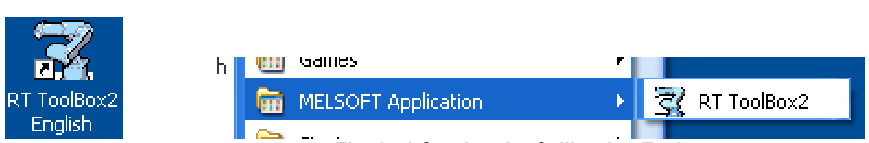


Fig. 17-1 Starting the Calibration Tool

This function can be used since RT ToolBox2 Ver. 1.3.

17.2. Starting the Calibration Tool

After starting the RT ToolBox2, connect to the robot controller to communicate.
After connecting to the robot controller, select the following item from the project tree of the workspace.

[Online] - [MELFA-Works] – [Calibration Tool]
(* [Calibration Tool] item not appear if MELFA-Works is not correctly installed.)

(* Refer to the RT ToolBox2 manual for details of the RT ToolBox2.)

17.3. Explanation of the Calibration Tool Window

The screenshot below shows the main window of calibration tool. This window is mainly used to check dot sequence data.

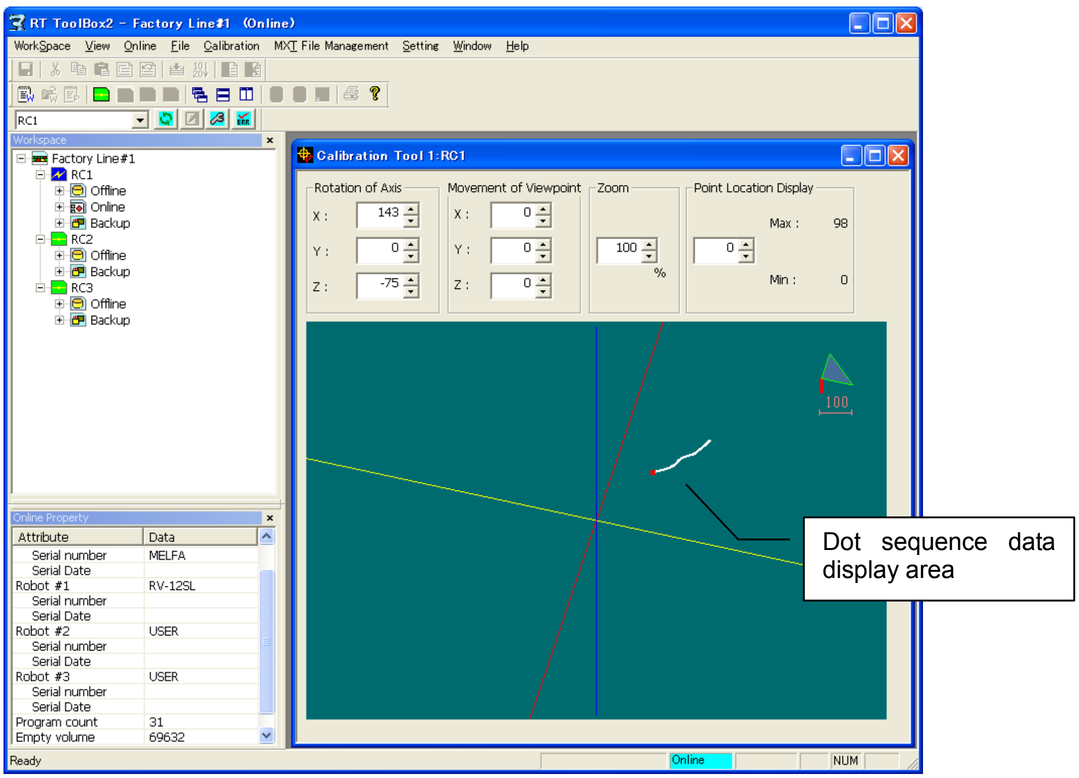


Table 17-1 Operations in the Calibration Tool Window

Item	Explanation
Rotation of Axis	Change the rotation angles of the coordinate axes in the dot sequence data display area by entering values directly or clicking the up/down button for each axis. It is also possible to change the angle by operating the mouse while clicking the Wheel button.
Movement of Viewpoint	Change the amount of parallel movement of the viewpoint in the dot sequence data display area by entering values directly or clicking the up/down buttons for each axis. It is also possible to change the amount by keeping the [Ctrl] key pressed and clicking the Wheel button of the mouse.
Zoom	Set the zoom scale of the dot sequence data display area by entering a value directly or clicking the scale up/down button. It is also possible to change the zoom scale by clicking the Wheel button, or keeping the [Shift] key pressed and then clicking the Wheel button.
Point Location Display	Displays the specified sequence of points in red.
Dot sequence data	Displays the loaded dot sequence data. The point “Point Location Display” specifies

display area	is displayed in red.

17.4. Open MXT file

Select [Open] in the [File] menu to specify an MXT file (*.mxt) output from MELFA-Works and load the dot sequence data.
MXT files contain data generated when creating work flows (refer to “10.4 Work Flow Creation).

17.5. Executing Calibration

After opening MXT file is completed, select [Position and Distortion Calibration] from the [Calibration] menu to display the Position and Distortion Calibration dialog box.
Calibration can be carried out by performing operations in the order displayed in the dialog box.

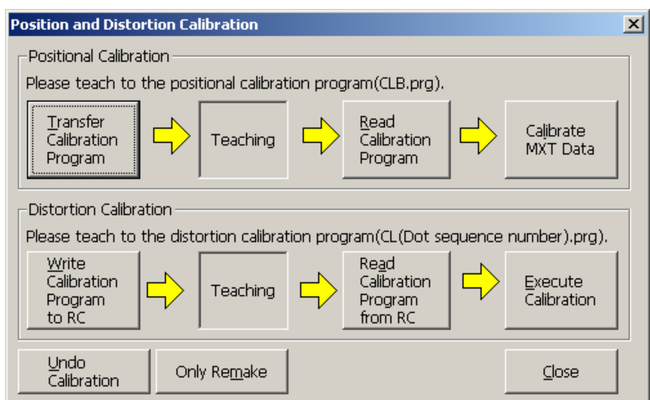


Fig. 17-2 Position and Distortion Calibration Dialog Box

Table 17-2 Operations in the Position and Distortion Calibration Dialog Box

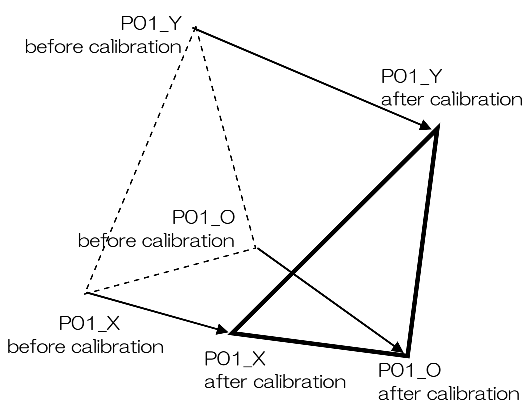
No.	Calibration method	Item	Explanation
1	Positional calibration	[Transfer Calibration Program] button	Transfers the calibration program to the selected robot controller. The program transferred here is the calibration program (CLB.prg), which is stored in the same folder as the loaded dot sequence data set.
2		[Teaching] (display only)	After transferring the calibration program, use a teaching box or similar to perform teaching. See the detailed instruction procedure in Chapter 17.6.
3		[Read Calibration Program] button	Reads the calibration program (CLB.prg) from the robot controller after teaching.
4		[Calibrate MXT Data] button (dot sequence)	Calibrates positions of dot sequence data. Use a calibration program (CLB.prg) uploaded from the robot controller to calibrate a dot sequence data set.
5	Distortion calibration	[Write Calibration Program to RC] button	Generates a distortion calibration program (with the name CL (dot sequence number).prg) and transfers it to the robot controller.

No.	Calibration method	Item	Explanation
6		[Teaching] (display only)	After transferring the distortion calibration program, use a teaching box and similar to perform teaching. See the detailed instruction procedure in Chapter 17.7.
7		[Read Calibration Program from RC] button	Reads the distortion calibration program (CL (dot sequence number).prg) from the robot controller after teaching.
8		[Execute Calibration] button	Calibrates distortion of dot sequence data. Use a distortion calibration program (CL (dot sequence number).prg) uploaded from the robot controller to calibrate positions of the dot sequence data set.
9		[Undo Calibration] button	Click the button to return the dot sequence data set to the initial status before calibration.
10		[Only Remake] button	Reconfigures a dot sequence data set with the current settings without performing positional or distortion calibration. Use this function to test a dot sequence data before calibration to the robot or MELFA-Works.

17.6. How to teach the positional calibration program (CLB.prg)

Select [Transfer Calibration Program] button on “Position and Distortion Calibration” window, the program named “CLB.prg” is transfered to the controller. This program is contained the positions for positional calibration which is set “Calibration” window of MELFA-Works.
Register the correction position in the program for positional calibration as the following procedures.

1. Using the teaching box (T/B) which is connected to the controller, set “CLB.prg” program to edit mode.
2. Jump to the step on line 20 and execute the TOOL command step. **<u>Calibration is impossible unless this line is executed.</u>**
3. Move the robot to each positions in this program (P**_O, P**_X, P**_Y(Each [**]is calibration data number in MELFA-Works)). At this time, be carefull to avoid collision to peripherals.
4. If the positions that were moved and which were set on MELFA-Works are shifted, move the robot to the position which is corresponds to an actual system and teach again.
5. Please operate the above-mentioned by all the registered position data.



(Calibration program sample)

```
10 ERROR 9199
20 TOOL (50.0, 0.0, 40.0, 90.0, 0.0, 90.0)
30 'CLB 01
40 MOV P01_O
50 MOV P01_X
60 MOV P01_Y
70 '
80 'CLB 02
90 MOV P02_O
100 MOV P02_X
110 MOV P02_Y
  :
```

Auto operation stop line

Execute step and set tool.

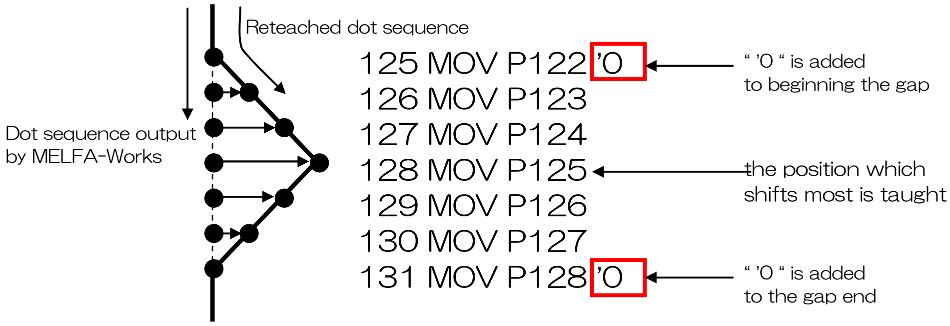
Checking the calibration position.

17.7. How to teach the distortion calibration program(CL(dot sequence number).prg)

Select [Write Calibration Program to RC] button on “Position and Distortion Calibration” window, the program named “CL(dot sequence number)” is registered in the controller. This program is contained all dot sequence positions.
Register the correction position in the program for distortion calibration as the following procedures.

1. Using the teaching box (T/B) which is connected to the controller, set “CL(dot sequence number)” program to edit mode.
2. Move the robot to each positions in this program, check the position set on MELFA-Works whether shift. At this time, move the robot noting no collision to peripherals.
3. If there is shift between moved position and a position set on MELFA-Works, “ ’0 “ is added to move

operation of beginning the gap and gap end position, and the position which shifts most is taught as shown in the figure below.



17.8. Transferring Dot Sequence Data to Robot Controller

When all calibration is finished, transfer the dot sequence data to the controller.
Select [MXT Transfer PC – RC] from the [MXT File Management] menu to display the Transfer Confirmation of MXT File dialog box.

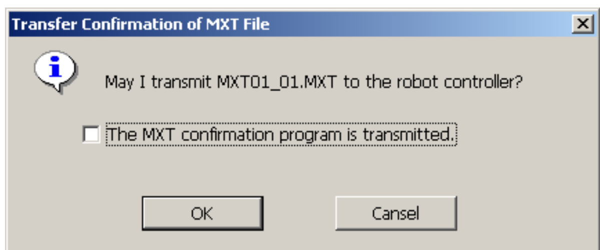


Fig. 17-3 Transfer Confirmation of MXT File Dialog Box

Click the [OK] button in this dialog box to transfer a dot sequence data set for which calibration has been completed to a robot controller. Also, by enabling the [The MXT confirmation program is transmitted] check box, it is possible to create a program (with the name 0101.prg) for confirming the robot movement and transfer it as well.

Using a program for movement confirmation will make the subsequent creation of robot programs easier.

⚠ CAUTION

Check movement carefully.

MXT instructions are used in movement confirmation programs (refer to Chapter 20 for the details). When using MXT instructions, the normal robot movement instructions are not used. Instead, the robot moves via commands from external sources (files or communication); it is thus **not possible to control the speed by the override specification** from a robot controller.
In order to avoid dangerous situations, pay attention to the following points and check the robot movement carefully.

- Always hold the TB with your finger over the stop button so operation can be stopped whenever needed.
- Create dot sequence data at a lower speed. See 17.9 "Movement Setting Change".
- Start up while physically separated from the robot.
- Start from a status without any workpiece.

17.9. Managing Dot Sequence Data in Robot Controller

The amount of dot sequence data that can be transferred to a robot controller is limited; use the MXT File Control in Robot Controller dialog box to delete unnecessary dot sequence data within a controller.
Select [MXT file Management in RC] from the [MXT File Management] menu to display the MXT File Control in Robot Controller dialog box.

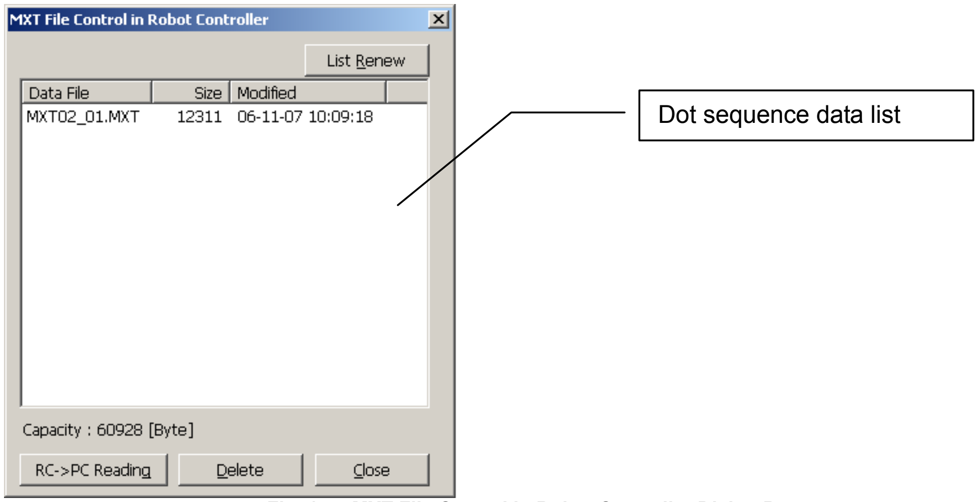


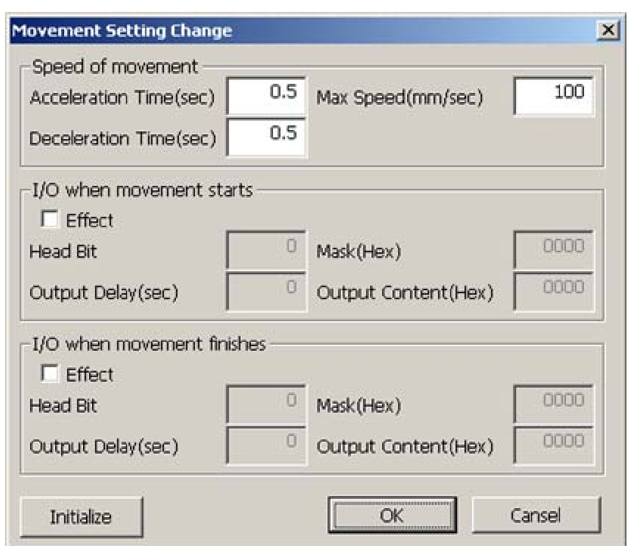
Fig. 17-4 MXT File Control in Robot Controller Dialog Box

Table 17-3 Operations in the MXT File Control in Robot Controller Dialog Box

No.	Item	Explanation
1	Dot sequence data list	Displays a list of dot sequence data existing in a robot controller.
2	[RC → PC Reading] button	Click this button to upload the dot sequence data set in a robot controller and save it in a specified folder on the personal computer.
3	[List Renew] button	Click this button to browse through the dot sequence data set in a robot controller and refresh the contents of the dot sequence data list.
4	[Delete] button	Click this button to delete dot sequence data selected from the dot sequence data list from the robot controller.
5	[Close] button	Click this button to finish MXT file management and close the dialog box.

17.10. Movement Setting Change

If the operation property is changed from initial state, this screen is used.
Select [MXT Parameter Setting] from the [Calibration] menu to display Movement Setting Change screen.



When this screen is shown, it displays the current state. Set only the changed item, and click the [OK] button. The state of the output signal changed on the screen in Chapter 17.11 is overwritten.

17.11. Editing Output Signal Status

Select [I/O Setting] from the [Calibration] menu to display the I/O Output Setting dialog box.
When outputting dot sequence data with MELFA-Works, the output signal settings are typically made for entire data sets at a time. This dialog box allows editing the status of individual output signals for each point; i.e., it allows the user to control I/O outputs in a detailed manner.

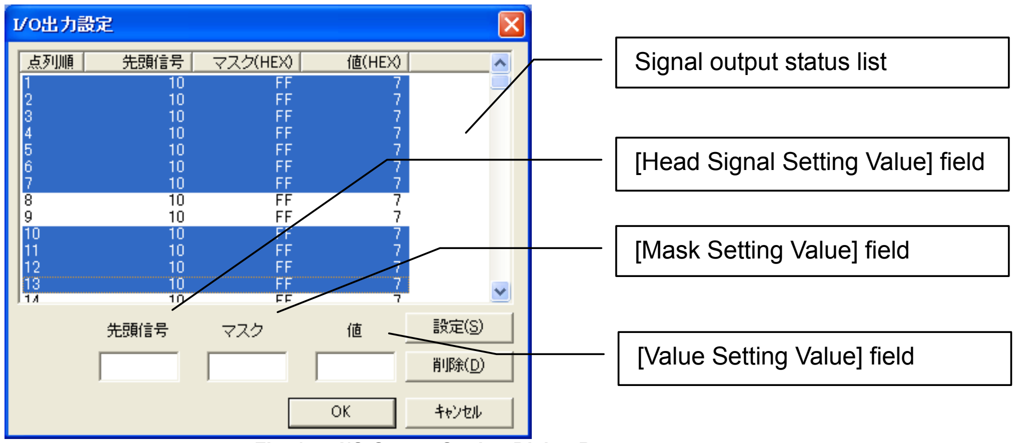


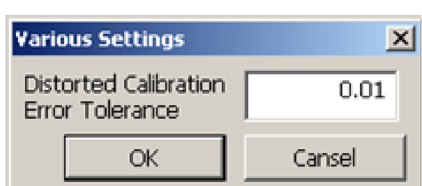
Fig. 17-5 I/O Output Setting Dialog Box

Table 17-4 Operations in the I/O Output Setting Dialog Box

No.	Item	Explanation
1	Signal output status list	The output signal status list displays the states of the output signals of all points. Select a point you want to modify from this list and set the output value in the corresponding text box.
2	[Head Signal] field	Specify the head bit to be output (decimal expression).
3	[Mask] field	Specify up to 16 bits that are permitted to be output, starting from the head bit (hexadecimal expression).
4	[Value] field	Specify the value to be output, starting from the head bit (hexadecimal expression). Only bits for which the corresponding mask bits are turned on are actually output.
5	[Setting] button	Sets the I/O output settings that have been made in this dialog box.
6	[Delete] button	Deletes I/O output settings that have been made.
7	[Cancel] button	Does not set any I/O outputs; instead, closes the dialog box.
8	[OK] button	Sets I/O outputs and closes the dialog box.

17.12. Change error tolerance when calibration

When dot sequence is reconstructed with the distortion correction etc., the error margin is caused in the process of the calculation. This screen is used to change the value (default value is 0.01mm).
Select [Various Setting] from the [Setting] menu to display Various Settings screen.



If the value is reduced, the accuracy at the distortion calibration etc. goes up. But the distance of dot sequence which can be corrected, shortens the accuracy or the distance of the dot sequence.
Use default vaule if there is no probrem for accuracy or the distance of dot sequence.

18. CAD Link Programming

So far it has been finished to create dot sequence data, perform calibration and transfer programs for test operations. This chapter explains how to construct an actual system using created data.
The CAD link function supports only the MELFA-BASIC language.

The following files are generated in the process of using the CAD link function.

Table 18-1 Files Output by the CAD Link Function

No	File name	Purpose/generation method
1	FLOW.prg	“Work program” This file contains a program converted from a work flow. Copy and use it as a template for your own programs.
2	O1O1.prg	“Movement confirmation program” This file contains sample programs for actually moving a robot using dot sequence data. * The file name is generated automatically according to the naming rule.
3	MXT**_**.MXT	“Dot sequence data (MXT data)” set This file contains dot sequence data describing robot movement along a workpiece. Downloading this file to a robot controller allows a robot to smoothly trace along the edge of a workpiece. This file is created by MELFA-Works and calibrated by the calibration tool. * The file name is generated automatically. After calibration is completed, change the name as necessary and use the file.
4	CLB.prg	”Calibration program” This file contains a robot program used in calibration. Executing this program allows teaching calibration points and calculating calibration values based on the results of teaching. This program is created by MELFA-Works and downloaded/uploaded by the calibration tool to/from a robot. The calibration tool uses the calibration program in the current folder as the source of dot sequence data. * The file name is fixed.
5	MXT**_**.cal	“Dot sequence data before calibration” This file contains dot sequence data before calibration. * The file name is the same as for the dot sequence data set above, but the extension is "*.cal."
6	CLB. cal	“Calibration program before teaching” This file contains a calibration program before teaching. * The file name is fixed.

18.1. Verifying Movement Confirmation Program

The movement confirmation program is structured as follows.

1 'MXT Sample Program (MXT01_01.MXT) Comment line
2 Tool (+0.00,+0.00,+231.00,+0.00,+0.00,+0.00) Set installed tool data. The tool data is calculated from the hand used when dot sequence data is output from MELFA-Works and set as the default value. This is required when creating an operational program as well.
3 Close #1 Close file #1 before loading a dot sequence data set. If the file is left open after the previous processing, an error occurs in the Open instruction in line 4. For this reason, it is typical practice to include a Close instruction before the Open instruction in order to prevent unnecessary errors.
4 Open "MXT:MXT01_01.MXT" As #1 Open the dot sequence file as file #1.
5 Mov P_Mxt Move to the beginning of the currently opened dot sequence data set. At the Mxt instruction on line 6, the robot moves according to the dot sequence data set; an error may occur if the current position and the head position are different. For this reason, the robot is moved to the position indicated by the first element in the dot sequence data set in advance.
6 Mxt 1,0 Move the robot according to dot sequence data of file #1. A detailed explanation of using the Mxt instruction is found in “18.2 Mxt Instruction (Move According to External Instruction).”
7 Close #1 Close file #1.
8 Hlt Stop the program.
9 End End of the program.

* The speed with which the Mxt instruction is executed cannot be controlled by the override specification of a controller; exercise caution when checking movement.

As can be seen with the example program for movement confirmation, a program is created in the following sequence to move a robot on dot sequence.

(1) Set a tool.
(2) Open dot sequence data.
(3) Move to the beginning of the dot sequence data set.
(4) Move through the dot sequence data set using the Mxt instruction.

This sequence is the same even when there are multiple dot sequence data sets to be traced.

18.2. Mxt Instruction (Move According to External Instruction)

With the Mxt instruction, data can be acquired not only from a file but also via Ethernet communication. In this section, it is explained how to acquire data from a file.

[Function]
Move a robot directly by acquiring absolute position data from a file in each control sample interval. The file is specified by the Open instruction.

[Format]
Mxt <file number>, <instructed position data type>[, <filter time constant>]

[Terminology]

<File number>	Specify a number in the range from 1 to 8; this value must match a file number assigned with the Open command. If the file specified to be loaded has not been opened with the Open command, an error occurs and a robot does not move.
<Instructed position data type>	Specify the type of position data commanded from the personal computer. Either XYZ or joint coordinate position data can be specified. 0: XYZ coordinate data 1: Joint coordinate data
<Filter time constant>	Specify a filter time constant (msec). If 0 is specified, no filtering is applied (0 is set by default if the specification is omitted). Apply filtering to position data to create dampened instruction values and output to the servo.
<File name>	Specify the name of the position data file loaded with the Mxt instruction.

[Example]

```
1 Open "MXT:SAMPLE.MXT" As #1      ' Open the SAMPLE.MXT file.
2 Mov P1                           ' Move to P1.
3 Mxt 1,0                          ' Move according to the real-time external control.
4 Close #1                         ' Close the file.
5 Hlt
```

[Explanation]
- By executing the Mxt instruction, it is possible to acquire position commands for movement control from the MXT file (format is explained later) specified by an Open instruction.
- In each movement control sample interval, one position command is acquired and the robot is moved accordingly.
- Operation of the Mxt instruction
  (1) When this instruction is executed with the controller, data is loaded sequentially from the MXT file and the robot moves to the specified position.
  (2) When all data in the MXT file is loaded, the Mxt instruction is completed.
  (3) If the movement is stopped via the operating panel or external input, the Mxt instruction is paused and remains in the paused status until it is resumed.

[Format of dot sequence data (reference)]
- The file specified as the source of position data must be a comma-separated text format file.
- If an apostrophe (‘) is placed at the beginning of a line, the line is regarded as a comment line.
- The format is as shown below ([1] or [2]).
  [1] XYZ data format : 1,<X>,<Y>,<Z>,<A>,<B>,<C>,<L1>,<L2>,<FL1>,<FL2>,
  <Presence of output 1/0>,<head bit number>,
  <Hexadecimal mask pattern 0000 to ffff>,<output data>
  [2] Joint data format : 2,<J1>,<J2>,<J3>,<J4>,<J5>,<J6>,<J7>,<J8>,
  <Presence of output 1/0>,<head bit number>,
  <Hexadecimal mask pattern 0000 to ffff>,<output data>
- The units are; XYZ component = mm, angle data = radian.
- Specify either XYZ or joint data format (cannot be changed in the middle).

18.3. P_Mxt Variable

[Function]

Load the position data of the starting point from the currently opened file. Note that this file must be a position data file that meets the requirements for being used by the real-time external control function (Mxt instruction). If a file has not been opened, all position data points are automatically assumed to be equal to the P_Zero variable (all axes at positioned at 0).

[Format]

```
<Position variable>=P_Mxt
```

[Terminology]

<Position variable> Specify a position variable that assigns loaded position data.

[Example]

```
1 Open "MXT:SAMPLE.MXT" As #1      ' Open the position data file.
2 Mov P_Mxt                        ' Move to the starting point of the file.
3 Mxt 1,0                          ' Move according to the real-time external control.
4 Close #1
```

[Explanation]

(1) Load the position variable for the starting point from the position data file of the real-time external control function (Mxt instruction).

(2) If the position data file of the real-time external control function (Mxt instruction) has not been opened, all position data points are automatically assumed to be equal to the P_Zero variable (all axes at positioned at 0).

(3) If a position data file meeting the requirements for being used by the real-time external control function is not used or there is no dot sequence data, the following error occurs when executing the Open instruction. The P_Mxt variable assumes that all position data points are equal to the P_Zero variable (all axes at positioned at 0).

Error number	Cause of error occurrence and countermeasure	
L7850	Error message	Cannot read MXT position file (Cannot load MXT position file that can be used by the Mxt instruction.)
	Cause	Illegal MXT position file (Not a position data file that can be used by the Mxt instruction.)
	Countermeasure	Correct MXT position file (Specify a position data file that can be used by the Mxt instruction.)

If the argument is set wrongly such as P_Mxt(1), an abnormal argument error occurs.

18.4. Precautions

(1) If the Mxt instruction is stopped in the middle, the robot maintains the position it had when the instruction was stopped. Due to this, the on status of the output signal is also maintained; the robot continues processing although it is stopped. In this case, turn the output signal off using the following method.

- Execute robot programs that have a signal initialization routine.
- Create an ALWAYS program and initialize (reset) the signal when the robot stops unexpectedly due to an error or robot stop, etc. See the instruction manual for that robot unit for more information on the ALWAYS program.
- Turn the signal off manually from the teaching box.

(2) The Mxt instruction moves the robot by loading dot sequence data. Since dot sequence data contains acceleration/deceleration information as well, if the robot is moving at high speed via the Mxt instruction, an error occurs and the robot may not be able to continue movement. For this reason, if the instruction is stopped in the middle, the safest way to continue is to evacuate the robot manually and operate it from the start.

(3) The Mxt instruction does not use interpolation by a robot controller but operates purely based on the information in dot sequence data. The speed therefore cannot be controlled via the override on the operating panel so use caution such as stopping immediately in case of unexpected movements.

(4) The Mxt instruction operates by acquiring posture data sequentially, but it may not be able to follow the robot movement perfectly; it may turn slightly inward depending on the robot speed and the curvature of a curve. Generally, this error tends to occur at higher speed or higher curvature.

(5) Robot controllers of system version K7 and later support the CAD link functions. (CRn-500)

(6) Extension memory can be used since Version K8 of robot controller. (CRn-500)

(7) Extension memory can be used since Version P7 of robot controller. (CRnD-700)

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